Lapidary Work as a Medium of Instruction
For the Industrial Arts Program

by

Alva Wayne Oliphant

A Thesis
submitted to
Oregon State College

in partial fulfillment of
the requirements for the
degree of

Master of Science

June 1948
APPROVED:

Head of Department of Industrial Arts
In Charge of Major

Chairman of School Graduate Committee

Dean of Graduate School
ACKNOWLEDGMENT

To Professor G. B. Cox, for his constructive criticism in the preparation of this thesis, the author owes a debt of gratitude.

For suggestions and assistance during the preparation of this study, the author is grateful to Dr. H. R. Laslett.

Acknowledgment is made to Bruce J. Hahn, assistant professor of industrial education, for his comments.

Appreciation is expressed to my wife for her inspiration, her assistance, and her patience during the preparation of this study.
"FOR LITERAL TRUTH OF YOUR JEWELS THEMSELVES, ABSOLUTELY SEARCH OUT AND CAST AWAY ALL MANNER OF FALSE OR DYED OR ALTERED STONES ** *
AND, AS A PIECE OF TRUE ** KNOWNLEDGE, LEARN TO KNOW STONES WHEN YOU SEE THEM UNEUT."  
- Ruskin
<table>
<thead>
<tr>
<th>TABLE OF CONTENTS</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>CHAPTER I. INTRODUCTION</td>
<td>1</td>
</tr>
<tr>
<td>Statement of the Problem</td>
<td>3</td>
</tr>
<tr>
<td>Sources of Information for this Study</td>
<td>5</td>
</tr>
<tr>
<td>Definition of Terms</td>
<td>6</td>
</tr>
<tr>
<td>Methods and Procedures</td>
<td>10</td>
</tr>
<tr>
<td>Scope and Probable Value of the study</td>
<td>11</td>
</tr>
<tr>
<td>Limitations of the Study</td>
<td>13</td>
</tr>
<tr>
<td>CHAPTER II. HISTORICAL CHAPTER</td>
<td>15</td>
</tr>
<tr>
<td>The Twelve Birthstones</td>
<td>23</td>
</tr>
<tr>
<td>CHAPTER III. THE STUDY</td>
<td>40</td>
</tr>
<tr>
<td>To Determine whether Lapidary Work should be Offered in the Industrial Arts Courses</td>
<td>42</td>
</tr>
<tr>
<td>To Determine Trends of Lapidary Work</td>
<td>48</td>
</tr>
<tr>
<td>To Determine Interest of Teachers in Learning Lapidary Work</td>
<td>50</td>
</tr>
<tr>
<td>To Determine the Length of Time Devoted to Lapidary Work in Secondary Schools</td>
<td>51</td>
</tr>
<tr>
<td>To Determine the Cost of Lapidary Equipment</td>
<td>53</td>
</tr>
<tr>
<td>To Determine the Number of Students that are Accommodated in Present Courses in Lapidary Work</td>
<td>54</td>
</tr>
<tr>
<td>To Determine the Sources of Material</td>
<td>55</td>
</tr>
<tr>
<td>To Determine the Content of a Course in Lapidary Work</td>
<td>57</td>
</tr>
</tbody>
</table>
# Table of Contents

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>To Determine on what Basis Lapidary Work Should be Offered in High School</td>
<td>58</td>
</tr>
<tr>
<td>To Determine on what Basis Lapidary Work is Offered in College</td>
<td>60</td>
</tr>
<tr>
<td>To Determine whether Lapidary Work Should be Included in Adult Education</td>
<td>63</td>
</tr>
<tr>
<td>CHAPTER IV. SUMMARY AND RECOMMENDATIONS</td>
<td>66</td>
</tr>
<tr>
<td>Summary</td>
<td>66</td>
</tr>
<tr>
<td>Recommendations</td>
<td>67</td>
</tr>
<tr>
<td>BIBLIOGRAPHY</td>
<td>69</td>
</tr>
<tr>
<td>APPENDICES</td>
<td></td>
</tr>
<tr>
<td>Appendix A. Suggested Setup of Lapidary Equipment and Description of Activities</td>
<td>72</td>
</tr>
<tr>
<td>Appendix B. Copies of Questionnaires</td>
<td>125</td>
</tr>
<tr>
<td>Appendix C. Copies of Letters</td>
<td>132</td>
</tr>
<tr>
<td>Table</td>
<td>Title</td>
</tr>
<tr>
<td>-------</td>
<td>----------------------------------------------------------------------</td>
</tr>
<tr>
<td>I</td>
<td>Comparison Between Mohs' and Gem Scales</td>
</tr>
<tr>
<td>II</td>
<td>Comparison of Returns of the Four Questionnaires</td>
</tr>
<tr>
<td>III</td>
<td>Showing the Desirability of Teaching Lapidary Work on the Secondary School Level</td>
</tr>
<tr>
<td>IV</td>
<td>Shows Comparative Value of Lapidary Work on Junior and Senior High School Levels</td>
</tr>
<tr>
<td>V</td>
<td>Shows Why Lapidary Work has never Been Included</td>
</tr>
<tr>
<td>VI</td>
<td>Shows Trends of Lapidary Work on Secondary School Level, College Level, and on Level of General Public</td>
</tr>
<tr>
<td>VII</td>
<td>Shows Teacher Interest in Taking a Course in Lapidary Work</td>
</tr>
<tr>
<td>VIII</td>
<td>Shows Number of Hours per Semester Devoted to Lapidary Work</td>
</tr>
<tr>
<td>IX</td>
<td>Shows Amounts Spent on Lapidary Machinery</td>
</tr>
<tr>
<td>X</td>
<td>Shows Numbers of Pupils Lapidary Machines will Accommodate at one Time</td>
</tr>
<tr>
<td>XI</td>
<td>Shows Amounts of Materials Purchased from Supply Houses</td>
</tr>
<tr>
<td>XII</td>
<td>Shows other Sources of Gem-Quality Minerals</td>
</tr>
<tr>
<td>XIII</td>
<td>Shows Contents of a Course in Lapidary Work</td>
</tr>
<tr>
<td>XIV</td>
<td>Showing Bases on which Lapidary Work Could be Taught</td>
</tr>
<tr>
<td>XV</td>
<td>Shows Purposes of Teaching Lapidary Work on the College Level</td>
</tr>
<tr>
<td>XVI</td>
<td>Shows Objectives of Lapidary Work on the College Level</td>
</tr>
</tbody>
</table>
Table XVII  Shows the Values of Teaching Lapidary Work in Adult Education Classes  . . . . . . . . . 63

Table XVIII  Shows High School Instructors' Ratings of Lapidary Work on the Adult Level  . . . . . 65
<table>
<thead>
<tr>
<th>Illustrations</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gem Stones</td>
<td>Frontispiece</td>
</tr>
<tr>
<td>Mojave Bloodstone</td>
<td>71</td>
</tr>
<tr>
<td>Drawing 1. Splash Pan Setup for Grinding Unit</td>
<td>78</td>
</tr>
<tr>
<td>Drawing 2. Cut-off Saw. For sawing of Slabs and Small Stones</td>
<td>80</td>
</tr>
<tr>
<td>Drawing 3. Sanding Unit</td>
<td>82</td>
</tr>
<tr>
<td>Drawing 4. Suggested Table Layout of Complete Lapidary Unit</td>
<td>87</td>
</tr>
<tr>
<td>Gem Stone Teaching Aid</td>
<td>97</td>
</tr>
<tr>
<td>Drawing 5. Some Suggested Cabochon Shapes</td>
<td>111</td>
</tr>
<tr>
<td>Drawing 6. The Willems' Faceting Device</td>
<td>114</td>
</tr>
<tr>
<td>Drawing 7. V-Dopping Block</td>
<td>115</td>
</tr>
<tr>
<td>Drawing 8. Facet Cut Stones</td>
<td>117</td>
</tr>
</tbody>
</table>
LAPIDARY WORK AS A MEDIUM OF INSTRUCTION FOR THE INDUSTRIAL ARTS PROGRAM

CHAPTER I

INTRODUCTION

Few trades have played a more important part in the making of history than the art of lapidary work. Long before the Pharaohs of Egypt, man adorned himself with small bits of minerals polished by the skilled hand of the lapidist. Wars have been fought over the question of possession of a small, highly polished piece of stone that would weigh but a few ounces. Even today, in many of the older countries, a person's wealth is not counted in monetary exchange but in the number of chests of precious and semi-precious stones he may possess.

Rare indeed is the man or woman who passes by the window of a jewelry store without glancing in admiration and perhaps with desire upon the array of beautiful, cut and polished stones on display. There is within all of us an instinctive appreciation of the beauty of a well-cut gem.

Only within recent years has the knowledge of cutting and polishing gems become known to the layman. This information was formerly a trade secret. Probably because of this fact, many laymen believe costly machinery and the development of highly skilled workmanship are prerequisite
to converting a rough bit of rock into a lustrous gem.

As a matter of fact, the actual purchase price of a lapidary unit is well within the range of any person of moderate means, while the appreciation and enjoyment gained from such an avocation is immeasurable.

Since the development of new abrasives in the early "thirties", lapidary work is beginning to be a useful, valuable, and practical hobby. With the advent of shorter working hours, many people are faced with the problem of filling their leisure time profitably. Through lapidary work, they can put these hours to use in the creation of objects of art, beauty and value. Already, many hobbyists in the nation have collected valuable specimens of cut and polished gems, at an outlay of little more than their spare time.

There is within all of us the urge to create beauty. For most people, caught in the monotony of everyday life, this urge is unsatisfied. The development of a hobby that will satisfy this desire was never more needed than in this mechanized age.

Lapidary work fulfills two objectives of industrial arts at the secondary school level. First, it illustrates an important phase of industry and art. Second, it can be used in the development of a worth-while hobby. Therefore, it seems to be well within the realm of industrial arts.
Statement of the Problem

It is the purpose of this study to determine whether or not lapidary work should be included in the industrial arts curriculum of modern education. Educators face a troublesome problem today in deciding what courses should be included in the industrial arts program, since they must choose from an ever-changing and expanding industrial field. From these broadening trends of industry, difficulty is encountered in selecting what should or should not be taught. The majority of schools either do not consider lapidary work important or know so little about the field that they consider it too technical or too expensive to incorporate into the industrial arts curriculum.

A very high percentage of boys and girls, after they finish the secondary schools, will earn their livelihoods by the use of their hands. It is a tremendous step forward if the teacher can help those young people ascertain their hidden talents, instead of turning them loose to find the work for which they are best suited through trial and error. Over a period of many years, they still might not be able to find the job in harmony with their natural abilities. If the teacher can give the pupils some sort of experience that will serve to guide them in selecting jobs after they leave school, the time spent with the students has not been in vain.
Lapidary work is one means of aiding in the solution of this problem. The richer the teacher can make the field of handicrafts within the industrial arts program, the greater the opportunity to help discover natural abilities. With two great wars behind us and uncertain times ahead, our nation today needs all the skill that its citizens have to offer. The shop teacher should endeavor to assist pupils in the selection of a good hobby and at the same time help them in the determination of their aptitudes. These are the attributes which give the greatest assistance to men and women in their search for the attainment of that position in life which offers enjoyable work, security, and satisfaction.

This problem has been broken down into the following purposes for this study:

1. To determine whether lapidary work should be offered in the industrial arts courses.
2. To determine trends of lapidary work.
3. To determine interest of teachers in learning lapidary work.
4. To determine the length of time devoted to lapidary work in secondary schools.
5. To determine the costs of lapidary equipment.
6. To determine the numbers of students that are accommodated in present courses in lapidary work.
7. To determine the sources of material.
8. To determine the contents of a course in lapidary work.

9. To determine on what basis lapidary work should be offered in the high school.

10. To determine on what basis lapidary work is offered in the colleges.

11. To determine whether lapidary work should be included in adult education.

The aim here is not to offer a complete course of study in lapidary work but to investigate the inherent possibilities of adapting this age-old art to any industrial arts program.

Sources of Information for this Study

The data for this study have been collected from the following sources:

1. Questionnaires to selected secondary schools, giving nationwide distribution both to schools which offer lapidary work and to those which do not.

2. Questionnaires to various universities and colleges that offer lapidary work.

3. Questionnaires to mineralogical societies.

4. Study of technical literature and professional publications in the field of lapidary work.

5. Interviews with home lapidists.
Definitions of Terms

Rock - All rocks may be classified under one of three grades, as follows:

1. Igneous rocks - those rocks which have solidified (cooled) from a molten condition. All other types of rocks are derived from igneous rocks.

2. Sedimentary rocks - those rocks which have been formed by the settling of sediments, usually in a body of water.

3. Metamorphic rocks - those rocks which have been formed from 1 and 2 under the action of geologic processes within the earth's crust.

Every rock carries within itself the evidence of its mode of origin. The recognition of these evidences is not so important to the lapidist as is the ability to select gem quality minerals from among them. This is of fundamental importance to the lapidists who must go into the field to find their cutting material.

Gem Quality Rocks - In speaking of rocks which have desirable gem qualities, it must not be supposed that this includes all occurrences of any particular mineral species. Only selected portions of certain minerals have desired qualities. A large number of diamonds taken from their bedrock are of no value for gem purposes, although they all may have commercial value of various degrees. Quartz, the most abundant mineral on the surface of the earth, has many
undesirable features that make a major portion of it worthless as gem material. A gem quality rock must have the necessary hardness, luster, color and transparency that make it worthy of display when cut and polished to bring out its hidden beauty.

Lapidist - The lapidist, both on the amateur and professional basis, may engage in the selecting, cutting, and polishing of stones between the hardness of five to ten on the Mohs' Scale. In this study, the discussion of cutting and polishing gems beyond the hardness of nine has been purposely omitted. Polishing gems of the hardness of ten, which is limited to diamonds, would require an outlay of equipment far too expensive to be practical and would employ such advanced technical knowledge that it would be entirely out of the range and the purpose for which this paper is intended.

The lapidist, in this study, is the amateur who practices the art of cutting and polishing stones between the hardness of five and nine on the Mohs' Scale, using inexpensive equipment.

Lapidary Work - The term used for the process of cutting, polishing, and setting precious and semi-precious stones.

Mohs' Scale - The hardness of a mineral may be defined as the resistance it offers to being scratched. This is an important aid in the identification of minerals but is
not wholly reliable in testing the authenticity of all gems. The hardness of a gem has a great deal to do in determining its value, if it is of remarkable beauty. The Mohs' Scale of hardness, which may be found listed in all standard texts on mineralogy, does not depict a true relation of hardness between various gems. In the following table, the Mohs' Scale is compared with the Gem Scale. Although the Gem Scale is rarely used, it actually shows the wide variations of hardness between some minerals.
### TABLE I

**Comparison Between Mohs' and Gem Scale**

<table>
<thead>
<tr>
<th>Mineral</th>
<th>Mohs</th>
<th>Gem</th>
</tr>
</thead>
<tbody>
<tr>
<td>Diamond</td>
<td>10</td>
<td>10,000</td>
</tr>
<tr>
<td>Norbide (Manufactured synthetic)</td>
<td>$9\frac{1}{2}$</td>
<td>4,000</td>
</tr>
<tr>
<td>Ruby (Natural and synthetic)</td>
<td>9</td>
<td>1,000</td>
</tr>
<tr>
<td>Topaz</td>
<td>8</td>
<td>450</td>
</tr>
<tr>
<td>Zircon</td>
<td>$7\frac{1}{2}$</td>
<td>350</td>
</tr>
<tr>
<td>Quartz</td>
<td>7</td>
<td>250</td>
</tr>
<tr>
<td>Agate</td>
<td>$6\frac{1}{2}$</td>
<td>225</td>
</tr>
<tr>
<td>Steel File</td>
<td>6</td>
<td>200</td>
</tr>
<tr>
<td>Opal (Variable)</td>
<td>$5\frac{1}{2}$</td>
<td>150</td>
</tr>
<tr>
<td>Glass</td>
<td>$5\frac{1}{2}$</td>
<td>150</td>
</tr>
<tr>
<td>Knife Blade</td>
<td>5</td>
<td>100</td>
</tr>
<tr>
<td>Copper Coin</td>
<td>3</td>
<td>0</td>
</tr>
<tr>
<td>Finger Nail</td>
<td>2</td>
<td>0</td>
</tr>
<tr>
<td>Talc</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>

**Field Trips** - The term "field trip" as used in connection with lapidary work is a method of gathering suitable cutting material for use in the school lapidary shop. It has no connection with field trips in other areas of the industrial arts program in the study of industrial shops, factories, or various occupations the community might have.
While lapidary field trips have educational value in the study of geological formations, rock strata, and occurrences of gem-bearing terrain, their primary purpose is to gather gem-quality rocks to offset the expense of purchasing minerals from lapidary supply houses.

Methods and Procedures

From a study of technical literature and professional publications in the field of lapidary work, a series of questions was selected which showed the teaching value of lapidary work. These questions furnished the basis for objectives to be used as the specific and direct aims of lapidary work in the secondary schools, as stated on page four.

A careful, analytical approach was then made to lapidary work, keeping the objectives of industrial arts in mind, in order to determine whether this work offers opportunities and situations typical of the aims of modern education. After careful consideration of the possibility that lapidary work had within itself the necessary educational values, skills and opportunity for self-expression so valuable to the industrial arts program, a suggested shop setup was prepared and is included as Appendix A of this study.

A survey was conducted by preparing a questionnaire and sending it to fifty-six secondary schools, giving nationwide distribution.
Special questionnaires were prepared and sent to thirty-four mineralogical societies, for their committees to report on the value of teaching lapidary work in secondary schools and on the adult education level.

A third questionnaire was sent to universities and colleges which include a course in lapidary work, asking the directors to state their opinions in regard to the value of lapidary instruction.

Personal interviews were conducted with home lapidists, asking their opinions of the value of such a course as lapidary work and their opinions of the correct procedure of instruction in the classroom of the industrial arts department. These opinions were incorporated into the information on teaching lapidary work which is placed in Appendix A of this study.

Scope and Probable Value of the Study

While hundreds of books, papers, and reports of various societies and states have been published on the subject of gems, little of this information is applicable to the industrial arts teacher. This information is far too technical and deals mostly with the history of gems, their identifications and their locations, with little adequate instruction on the methods of cutting and polishing which would apply to the school classroom. The above knowledge is quite necessary if a scientific study of gems is to be made, but the
shop teacher who wants these data in non-technical language may experience great difficulty in locating them. Often, he must depend upon some local lapidist for assistance.

This study contains the fundamental principles for the cutting and polishing of stones, through the hardness of nine on the Mohs' Scale, as now taught in shop classes in many secondary schools in the United States. Non-technical language is employed, with the view of encouraging a wider understanding of the lapidary art on the secondary school level.

The study is intended to run in harmony with the efforts of those shop instructors who constantly endeavor to improve their skills in the art of portraying beauty and to enrich life for their students.

The results of this study should be of value to handi-craft instructors desiring to enrich their programs by finding new media to encourage self-expression and to help students select worthwhile hobbies.

While lapidary work can be included within the program of any industrial arts shop with little expenditure for equipment, there are many schools in the nation where such a program would be in perfect harmony with the surrounding geological survey. There are many hundreds of schools west of the Mississippi which are surrounded with such an abundance of natural mineral wealth that a course in lapidary work would give their students many hours of added pleasure.
within the classroom as well as on well-planned field trips selecting stones suitable for gems and collecting different minerals.

Helping students on the secondary level to make use of their leisure time is an important factor with which our educators are faced today. Lapidary work provides stimulus and incentive to better work and more adequate expression of creative urges. This paper is meant to offer one of the solutions to this problem.

**Limitations of the Study**

The geographical limits of this research are the boundaries of the United States, corresponding with the purpose of the study, which is to evaluate throughout the United States the importance of lapidary work in the program of secondary schools, with particular emphasis on schools west of the Mississippi River. The schools which offered lapidary work provided a great deal of information, as well as schools which did not offer lapidary work. Colleges and universities teaching lapidary work provided information.

To get a wider understanding of the teaching value of lapidary work on the secondary level and adult level, the opinions of several mineralogical societies were included in the study.

No attempt has been made to evaluate lapidary work from a vocational standpoint. The questionnaires used as
a means of securing information were designed to be answered by checking or completion, to be defended or condemned. The opinions or remarks gathered are only as reliable as the people who participated. It must be stated here that the opinions of mineralogical societies do not represent the opinions of the secretaries of the societies only, but the opinions of the societies as a whole, which may include twenty-five to two hundred and fifty members, or more. It is believed that mineralogical societies represent a qualified opinion on the value of lapidary work in the secondary schools, since the members are specialists in this field and come from every level of society.

A suggested arrangement of lapidary equipment and description of activities has been completed for school use and is included in Appendix A of the study. It was not prepared as a complete program for any school. Suggestions covering classroom procedure are the opinions of amateur and professional lapidists and include effective teaching methods discovered through the actual teaching of lapidary work on the secondary school level.
CHAPTER II

HISTORICAL CHAPTER

Gems, in their appeal, are like the stars. They kindle the imagination, they captivate the eye, and they have a history that dates from thousands of years before the birth of Christ. The halls of history have never been able to establish a date when man first began to adorn himself with bits of highly polished minerals. The deeper archeologists dig into the past centuries, the more amazed they become that man was able to cut, engrave, and carve tough minerals hundreds of years before the discovery of metal. A priceless stone is one thing that defies the erosion of time. Fine silk is soon a rag, velvet worthless, flowers dead; but a gem may live forever.

Out of the ancient graves of Egypt, Syria, Mexico and the Near East have come beautiful examples of the lapidaries' art. In the Metropolitan Museum in New York City, and in many other museums throughout the world, are hundreds of gems carved into signets, seals, rings with superb engraving and cabochons, taken from the oldest tombs in both the new and the old world.

Is there a richer syllable than "gem"? The very word evokes a picture in our minds. To the jeweler, it may mean the perfect jewel. To the wealthy, it may denote position. To the average person, it may mean luxury or appreciation.
of the beautiful. For thousands of years "gem" had a meaning which is entirely different from the meaning today. To the mineralogist it does not necessarily suggest a valuable stone; it may be any engraved stone, whether it be precious, semi-precious, or simply a bit of hard marble. It stands not only for personal decoration but for world progress. The lapidist, more than any other artisan, has recorded in an unperishable form the history of the ancients, their mythology and the development of the arts. The work of the ancient lapidists played a large part in proving the authenticity of documents. "Gems" are truly one of the few unperishable arts of ancient civilization.

The earliest records of the manner in which stones were cut and polished were found painted on the walls of Egyptian tombs. Because these drawings and the records passed on to us were incomplete, the process by which the early lapidist performed his beautiful work is uncertain.

At first, the cutting and polishing of a stone must have been a crude and tiresome method. It had to be done by hand, using emery and pulverized corundum. Only one side was polished in the early examples, with little change in the actual shape of the stone itself. In spite of these handicaps, the degree of perfection some races of people attained in the lapidary art is still a mystery to present-day geologists. The British Museum of London has on display the reproduction of a human skull, lifesize, perfect
in all details, carved from a solid piece of clear, highly polished quartz. This was the work of some ancient lapidist of the Aztec race. Many beautiful articles have been found in Mexico, worked from the most friable of all minerals, obsidian, a volcanic glass which is extremely hard. The Aztecs worked many minerals of great hardness into beautiful and intricate designs to be used as adornments upon their persons.

Minerals of such extreme hardness as sapphire, ruby, and even diamond were cut and polished, and a few were drilled for ornaments to hang from the ears or neck. Time meant little to the ancient lapidist.

China is well known for its examples of dishes, lamps, and highly intricate figures carved from jade, quartz, agate, and many harder minerals. Modern man wonders how long it took to carve and polish such incomparable objects of art. Trades were closely adhered to in old China. What the father started, the son would continue until finished; or a grandson would carry the work through to absolute perfection. With the crude tools and abrasives known to the ancient lapidist of China, in one lifetime a man could scarcely do such painstaking work as is evidenced by some of the articles still in existence.

The father of mineralogy, as proclaimed by many historians, was Theophrastus, disciple of Aristotle. Fortunately, his writings on gems were incorporated into the
works of Pliny. After a life devoted to constant study, Pliny perished in the destruction of Pompeii in 79 A. D. However, Pliny's works were written from the romantic rather than the realistic viewpoint. Two hundred years later, a jeweler, Solinus, took Pliny's work on gems and, with his good knowledge of stones, greatly improved upon the two books of gems which Pliny had written.

For the next twelve hundred years few actual facts were written about gems. The books by Solinus were considered the highest authority in the field. In 1609, a doctor named Aselmes De Boot, a native of Antwerp, published "De-Gemmis et Lapidibus." He referred to the works of Solinus, and himself wrote about the medical value of gems, describing the power of different minerals to heal the sick. While his medical theories are of little value today, he did advance the knowledge of minerals by giving accurate descriptions of the gems known at that time.

C. W. King, an English scholar and gem expert, was the first writer to combine the ancient with the modern natural history on the subject of gems. King worked out a system whereby he could identify the true names of the minerals spoken of in the works of Solinus and others. His task was a tremendous one, but it is to him we owe many of the modern interpretations of the stones mentioned in the Old Testament. It is interesting to note that the diamond is mentioned in only two places in the Bible:
Exodus 39 and in one line of Jeremiah. Pliny claimed to have seen the first gem recognized as a diamond. It was then in the possession of the King of Persia. King's writings made no mention of the diamond prior to the first recorded cutting of a diamond, by Louis Van Berghem in 1475. It seems logical that diamonds referred to in the Old Testament were of softer mineral such as emerald or clear quartz. Diamond, cut and polished, has been found rarely in any of the old tombs of the Near East. Emeralds and rubies, minerals next in hardness to diamond, were found in these tombs, superbly worked. In reading the interpretations of the Bible, one can never be quite certain whether a ruby was a ruby and a diamond a diamond, as we know them, or just pieces of red quartz or rock crystal, highly polished.

Previous to 1690, nothing was known of the refraction possibilities of gems. The stones were usually water-worn pebbles, polished on one side, with the more transparent type faceted to a small degree. The art of faceting as practiced today began to find its stride in the last of the seventeenth century, when gems were double cut to yield greater beauty. Great advances were made in the early part of the 1700's, although the gems from the Far East were still cut, faceted and polished to lose as little as possible of their weight. Even today in China and India, the source of the majority of precious stones, we find little
improvement in the techniques of cutting and polishing hard minerals. Beauty is generally sacrificed for weight. Before the stones can command a high price in the world gem market, they must be recut to bring out their true beauty.

Through the ages, each stone of different color was symbolic of some belief. Some were used in special ceremonies while others designated position and rank of office. Stones of certain colors are still symbolic of certain things. A clear white stone is for innocence and happy living. Red stones have divine powers, passion and love. Green stones stand for hope and faith, blue stones for truth. Purple is the symbol of mourning, suffering and humility. Yellow, the color of the sun, the power of light, indicates the strength of God. (12:P.86)

There is little doubt among historians studying age-old documents that various dignitaries had their own particular choices of gems carefully carved into signet rings, which they in turn used as seals for personal documents. Verril (12:P.87) states

"It would be most interesting to know what variety of mineral formed the signet of Darius when he used it to seal up the lions' den into which Daniel had been cast, or what stone bore the seal of Ahab when Queen Jezebel employed it for signing letters she had forged. And what stone was engraved with the signature of the Roman general, Marcellus, when it was filched by Hannibal, who by its use came very close to winning
a great victory."

Even today, the belief in the symbolism of stones is still quite prevalent, although true meanings have been forgotten. It is quite a common belief among some groups of individuals that the Pope must always wear an emerald, bishops amethysts, and cardinals rubies. This is not a compulsory rule and many of the high dignitaries of the Roman Catholic Church wear any stone that suits their fancy. It is true, however, that the Pope wears a beautiful emerald, and this same stone has been worn by Popes since the downfall of the Inca race during the 1500's. From the Inca treasure house, a very fine, large emerald was presented to the Pope by Pizarro. Since purple is the official color of the robes of bishops, it is quite customary for them to wear amethysts.

Throughout the ages, stones have become so surrounded with traditions and legends that it is almost impossible to sift the truth from fiction. The stories make interesting reading, particularly since the birthstones of today are the results of this folklore. The superstitions connected with the twelve stones of the year are remnants of age-old stories. Birthstones are now more of a tradition. Few superstitions are connected with them, although they are not entirely free from peculiar beliefs.

In the second book of the Bible, Exodus 39, we find mentioned twelve stones of the High Priest's breastplate.
Although interpretations of the twelve stones used are not definitely known, ten of them apparently correspond to our present-day birthstones. Among gem authorities today, the following list of stones has been accepted as a fairly accurate list of the true names of stones of the Bible.

(12: P. 126)

"Jasper (probably carnelian)
Ruby (probably carbuncle)
Topaz (probably citrine)
Carbuncle (probably garnet)
Emerald
Agate
Diamond (probably rock crystal)
Amethyst
Onyx
Zircon
Sapphire (probably lapis lazuli)
Beryl (probably peridot)"

Zircon and beryl are the only two stones of these twelve not included among the popular birthstones of today. During the Middle Ages, from the beginning of Zodiacal Science, beryl was used by all nations for the birthstone of October. It is now replaced by the opal. Zircon has never been used as a birthstone.

Many people wonder why certain stones have been named to represent each month of the year. Early astrologers stated that a certain gem was possessed of great power during a given period of time, when a specific sign of the Zodiac was in its ascendancy. This time corresponds roughly with our months. The emerald, for example, would be particularly powerful for a person born in May, or under the sign of Taurus, the Bull. It is impossible to know what
connection there is between the twelve birthstones of astrology and the twelve stones of the Bible, but it is an interesting fact that they are the same.

The average modern is without words to express his reaction to the wonder and superstitious awe with which the ancients regarded gems. A stone was every man's talisman in sickness and in health, in his work, his travels, in everything he did. He clutched his little bit of mineral to his breast, for it was his magic, his strength against the powers of ignorance, evil and cruelty that characterized the Middle Ages.

THE TWELVE BIRTHSTONES

January - Garnet

The garnet has been known from early times and once commanded a high price in the field of gems. Garnet has been mistaken for ruby, for countless ages. In many parts of the United States today, it is sold under the name of ruby, i.e. Montana ruby, Cape ruby. Many garnets have been sold to the unsuspecting customer as true rubies under these misleading names. The lustre of the garnet is vitreous and quite easily chipped. The ancients valued it mostly for its color and not for its hardness. Garnet has been the birthstone for January for many thousands of years. It was the emblem of constancy. No other gem has replaced garnet as
the first stone of the year. Under old superstitions and beliefs, garnet protected one while at sea and on land. It guarded the wearer from sickness or sudden death; it preserved health, and sudden loss of brilliancy was a warning of coming danger. In many parts of the world, the belief still exists that he who wears a garnet will be helped towards success and will be protected against accidents while traveling.

February - Amethyst

Amethyst comes under the quartz group and is the best known of this abundant mineral. It is the most valuable of the quartz gems and varies in color from deep purple to a faint lavender.

It was the custom of the early Romans to drink their wine from a cup made of amethyst, since it was believed to have the power of protecting the owner from intoxication. It was also believed that when presented as a gift, amethyst promoted deep love.

Amethyst was once greatly valued by the ancients, and today will command a fair price on the gem market if the crystals are of the right color and transparency and are correctly mounted.

Amethyst crystals are found in many parts of the United States, notably North Carolina and Virginia, but the deposits yield few stones of true gem quality. The most beau-
tiful, a rich, royal purple, is found in Siberia.

**March - Bloodstone**

The quartz group is so large as to appall one. Widely distributed over the surface of the earth, it is one of the most common of minerals. Bloodstone is of the quartz group. Many historians believe the name originated when the stone was found under the Cross of Calvary, stained by the dripping blood of Christ. To this day, it is known to the Italians as "bloody Jasper" (14:F.132).

Bloodstone is also known as heliotrope and is of the green jasper minerals, with small spots of red speckled on its surface.

To wear a bloodstone is to give one great courage, strength and wisdom. The Greeks believed if the stone were placed in water, it would cause the water to boil since it had the heat of the sun. The Paris Museum has a bloodstone bust of Christ carved in such a manner that the red specks appear to be drops of blood. Bloodstone has been the object of superstitions, legends and myths for countless ages.

During the Byzantine period, bloodstone was highly prized as a gem stone. There has rarely been a substitute to replace it as the third stone of the year.

**April - Diamond**

To explain the composition of a diamond is a simple task for the chemist, since it is pure carbon. To describe
the processes in the formation of the stone, however, has been the despair of the scientist for ages. No mineralogist can tell exactly how it was made, and no chemist has ever succeeded in making one. It is the general belief that diamonds were formed under terrific pressure and heat, over a long period of time. This would have a great deal to do with the crystalline formation. No further explanation has ever been given which would shed more light on just how the diamond was formed.

It is only within comparatively recent times that the flashing brilliance of a diamond has become manifest, based upon the development of faceting and a study of the reflective index.

Due to the extreme hardness of the stone, all diamonds in the rough are under some sort of internal strain. Several fine, uncut diamonds have been ruined by being accidentally dropped on a hard floor or struck against a hard object while they were being graded. This is due to the perfect cleavage of the diamond.

Many people believe the diamond commands such high prices due to its rarity. This is far from the actual truth. In certain parts of the world, diamonds are found in vast numbers, and, if released upon the world gem market, the stones would fall far below their present value. Today the majority of diamond mines are controlled by a shrewd and powerful syndicate. By releasing a certain number of
diamonds on the market each year, the price of this ex-
quisite stone is kept up.

Few superstitions have grown up around the diamond,
but its great hardness and mysterious origin have always
been a source of much bewilderment. The Ancients believed
that if the diamond were placed on an anvil and struck with
a hammer, both the anvil and hammer would be torn asunder.
This method of testing diamonds was a common practice cen-
turies ago in India and probably resulted in the ruination
of many fine stones.

All of the large diamonds of early origin have become
involved with many legends.. They have been the direct cause
of crimes and of the actual downfall of some countries.
Some of the larger diamonds have been the chief factor in
the financing of wars.. The diamond at one time was consid-
ered a talisman in battle and protection from poison.. In
the remote past it was used for the detection of infidelity.
A writer of the eleventh century stated that it had the
power of quenching the heat of certain fevers.(14:P.133)

Although the diamond is the birthstone for April and
has been so for many hundreds of years, many people prefer
the sapphire in place of the diamond as the April birthstone.

May - Emerald

The emerald, its color a rich, deep green, has been
long considered the flower of the gem family. Not only is
it the rarest of all gems, but, if of fine quality, far outranks the diamond, carat for carat of weight.

It was Pliny who said that a universal agreement had been reached for lapidists not to engrave a gem so valuable as this stone. Engraved emeralds found today among the ruins of once great civilizations are the rarest of all gems. The ancients believed that the emerald would reveal the inconstancy of lovers by changing its color. It helped its wearer to resist corruption and temptation, and, as late as the seventeenth century, powdered emerald was used as a drug.

During the time of the Spanish conquest of Peru, the Indians had been working several mines for the highly prized emerald used in their religious ceremonies. The natives concealed the workings so well they have never been rediscovered. As the story goes, one of the Spanish conquerors, Don Alvarado, was said to have doubted the genuineness of these fine stones brought in by his followers and put each one to test under the blows of the hammer.

Fine emeralds are found in only a few places in the world today. Probably the best source of this beautiful gem is the northwest section of Colombia, near Bogota. The mines are very old, and the output of really fine gems is quite limited.

Emerald has long been the birthstone for May, but
centuries ago, different sections of Europe became divided on the subject, some preferring the agate. Moderns prefer the agate for June and the emerald for May.

June - Agate

Among the cheapest of the semi-precious stones, we find the agate. It is the most important species of chalcedony, as it is the most abundant and most worked in amateur lapidary shops throughout the United States. There are so many different variations of this particular mineral that it is not worthwhile to list them. Agate may be found in any color of the rainbow, or one stone might include all of these colors. The most usual shades of agate are milkwhite, yellowish, brown, red, with the more unusual colors being blue and deep green.

It is quite a simple process to dye agate to get almost any desired color. This has long been a flourishing trade of European lapidists.

The moss agate is generally supposed to contain real moss, but this is erroneous. The visible impurities are due to oxide of a green mineral. Onyx is an agate with alternate black and white bands. Sardonyx and carnelian are both of the agate family, contrary to the misconceptions held by many people.

The odd formations which the impurities in an agate assume have led to many narratives of their actual formation. One popular belief about the manner by which the exact
likenesses of animals, trees, grass and mountain terrain are formulated in the agate is still quite prevalent today. A perfectly clear agate if kept from being exposed to the sun and in a damp place will through chemical processes collect a coat of hypo highly sensitive to light. If anything, such as a deer, dog, or heavy winds, should disturb the stone from its dark enclosure, the first rays of light striking the highly sensitive coat of hypo on the surface of the agate will photograph any object within a short distance. It is surprising what fantasies some people will still believe.

Today, cameos of the better qualities are made from onyx and sardonyx. Many ancient seals and other articles have been found worked from agate, which shows that this stone had some value centuries ago.

A stone used so much by the ancients is not without its strange beliefs. Agate supposedly signifies health, wealth and longevity. The term "agate" is derived from the river Achates in Sicily, where Theophrastus says specimens were found.

Agate has been the June birthstone for hundreds of years.

**July - Turquoise**

Turquoise, the birthstone for July, is sometimes considered as the alternate birthstone for December. It is
not a true jewel. It is inferior in hardness to all gemstones except the opal, which is about the same hardness. It owes its popularity to its beautiful greenish-blue color, which is exquisite when set in gold. Turquoise is not a true stone; it belongs to the phosphates - the only gem of that group.

Like other birthstones, turquoise is surrounded by ancient beliefs. The turquoise is supposed to bring prosperity, and if the wearer becomes ill it will lose its color. It is a soul-cheerer and prevents newly married couples from becoming irreconcilable after marital quarrels.

The cheaper grades of the mineral are used extensively in costume jewelry, which has done much to cheapen a really beautiful mineral.

The finest turquoise in the western hemisphere comes from New Mexico, Arizona, California and Nevada. The finest grade of all comes from Mexico. There are immense turquoise deposits in Old Mexico that were worked by the Aztecs. Some of these mines have been re-excavated and now produce a superior quality of this mineral.

August - Carnelian

Due to its pleasing red color, carnelian has long been a very popular stone. It belongs to the quartz family of minerals and was widely used by the ancients for carving. Since it is not an extremely hard stone, it was probably
among the first of stones to be carved.

To wear a carnelian is to give one great courage. If the owner is wounded in battle and the stone is placed against the raw flesh, it will stop the flow of blood. Today, some still hold the age-old belief that if one is born in August to wear a carnelian is to ensure conjugal love.

The carnelian is found, along with other formations or deposits of agate, in many parts of the United States. Many a fine carnelian has been picked up along roads that have a graveled surface, mixed in with other small agates of various shapes and colors.

**September - Sapphire**

Sapphire, one of the most beautiful of gems, is corundum, the hardest of all substances except diamond. It has also been called hyacinth, deriving its name from Greek mythology concerning the death of Hyacinthus. For centuries, controversy raged over the question of whether or not the sapphire has been called by the correct name, but Solinus in 250 A.D. described the hyacinth exactly like the sapphire of today.

The sapphire comes in many varieties of colors: green, violet, salmon pink, yellow and the most popular of all, blue. White sapphire, when cut brilliant, has sold many times for diamond. It actually lacks the prismatic play
and sparkling beauty of the diamond.

Sapphire is the easiest of all stones to reconstruct. The synthetic product, when cut and faceted, is often more beautiful than the natural stone itself.

In medieval times the stone was considered to have a certain amount of magic attached to it. It was used to cool the blood, and it would guard its wearer from insanity. Due to its heavenly color, sapphire was long used as a guard against devils and evil powers. Pope Innocent III commanded all bishops to wear sapphire rings in view of these beliefs. (1413P.131)

For many years, the main source of this stone has been from India, although America is not without its representation of this stone. Quite fine stones have been mined in Montana deposits since 1865. The Montana gems are small, but of beautiful color and quite lustrous.

A large sapphire has been set in the cross surmounting the English crown. It truly commands the position as the ninth stone of the year.

October - Opal

Of all the beautiful gems, Pliny says the opal is the most difficult to describe. Within the depths of this one gem is combined the beauty of them all. The Romans valued the opal far above any other material and considered it much too costly and rare to engrave.
Empress Josephine was supposed to have possessed one of the finest fire-opals of modern times. It was called "The Burning of Troy". No one knows for certain just what happened to this beautiful gem, however the American Museum of Natural History has an extremely large, red opal. Within its center, it has the luminous effect of a pulverized mirror. It is possible that this stone could be the "Burning of Troy".

No ill effects were connected with the opal by the ancients. It could bring its wearer nothing but good. During the 1800's, strange stories boiled around the opal until the belief became pronounced that death or extreme bad luck would befall any owner of an opal. This caused a considerable drop in the price of the gem. However, this belief does not exist today, and it is considered good luck for one who is born in October to wear an opal.

The opal commanded extremely high prices until the discovery of the Mexican mines in the nineteenth century. Since then, they have become so plentiful on the market that they have fallen into the semi-precious class of gems.

Opal has never been replaced as the birthstone for October.

November - Topaz

The present-day gem stone of topaz has been known for only four hundred years. The word "topaz" is derived from
an island in the Red Sea, Topazios, from which the earliest stones originated (14:F.65). Specimens found in upper Siberia cannot be subjected to much light, as they will fade or become a dirty white. The finest topaz crystals come from Brazil, having been discovered there in the sixteenth century.

The gems are usually in shades of golden yellow, although they may be tinted with rose, red, or a slightly greenish effect. The average jeweler in the display of his finest stones in topaz would be most apt to have nothing but the golden-yellow shades to show. Although the word topaz connotes the golden-yellow colors to most people, the gem does come in several different shades of color.

Chemists have not been successful in the reproduction of topaz, but very fine glass imitations have been sold on the market for a great number of years. The imitations are made from a fine substance of strass but lack the hardness of the true stone. Lapidists today are cutting the smaller stones into brilliants, and the larger stones are given the step cut the same as sapphire. This system of faceting the gem greatly enhances the charm of the stone.

The correct nomenclature for the genuine topaz is "Brazilian Topaz". Oriental topaz is merely yellow sapphire, and Scotch topaz is yellow quartz. The hardness of true topaz is a good test, since it is the third hardest stone found. Imitations, such as quartz or glass, are all
in inferior in hardness.

Like the other gems, topaz was surrounded by strange beliefs. The topaz was a favorite stone for newly married couples, and if held in the hand, it lessened suffering for a woman in childbirth. It was considered a gem of friendship and helpfulness for many years.

Though a comparatively recent mineral, topaz has been a birthstone of all nations for four centuries.

**December - Ruby**

The ruby has been known under many different names since the beginning of history. It was always difficult for the ancients to distinguish among the many red stones picked up in stream beds and mining excavations. It is only in recent times that the ruby has been isolated into its true position. To the jeweler or the lapidist, the ruby is only a red sapphire.

Since the ruby is so much like spinel, the red garnet, and the tourmaline, it was always quite easy to sell one of the cheaper stones to the layman as a genuine ruby. Before the discovery of the method of making synthetic sapphire and ruby, it was not too difficult to distinguish between the authentic stones and the false, since the genuine is next to the diamond in hardness. Also, a genuine ruby if held up to the light will appear clear and bright throughout, while garnet, spinel and other red stones show up dark or almost opaque.
The "pigeon's blood" ruby is considered by many to be the peer of all stones. A stone of good size, without flaws, has far greater value than the diamond or sapphire.

The ruby, a gem admired and cherished through so many centuries, has many fables and legends woven around the burning fire in its center. It was said to have the power to light up a darkened room, and the only light that Noah had in his ark was that of a ruby. The gem was supposed to change color if disaster were approaching for the wearer. Marco Polo wrote that the king of Ceylon had the finest ruby in existence. Kublai Khan offered the value of a city for this stone, but the king said he would not part with it if the wealth of the world were laid at his feet.

In Burma, the belief is still quite pronounced that the ruby is first white and then ripens to a bright red in the earth (14:P.131).

The ruby has been the birthstone of December for all nations for many centuries, except for the Poles and the Russians, who alone use turquoise.

There are many other stones that are worthy of comment, but space does not permit their interesting legends to be added here. There are only a few men within the last seventy-five years, besides Dr. Max Bauer, who have written authoritatively on precious stones. Some of these are Emanuel Streeter, W. R. Cattelle, and J. W. King, whose
real specialty was carved gems. Tiffany's of New York City have long been the leading jewelers in this country. They have established the authenticity of many gems and set their price. Tiffany's are still one of the leading gem distributors in the United States.

Lapidary work as we know it today had its beginning in the early 1700's. However, the greatest strides in lapidary work have been made in the last forty years. The development of silicon carbide and norbide, cutting compounds, placed the age-old art of gem cutting within the reach of every interested person. These new and improved abrasives have speeded up the production of gem stones, so that the work now involves a fraction of the time previously required. Not until the last twelve years has the simple knowledge of lapidary work spread across the country as a hobby among amateur lapidists.

Every lapidist, be he amateur or professional, develops his own best method of cutting and polishing a stone. Much of the work of the amateur shows greater perfection and beauty than will be found among professionals, who must work fast in order to make a profit.

Lapidary clubs are multiplying rapidly in all sections of the United States. In some states, the lapidary hobby has reached such proportions that state-wide exhibits are held on a competitive basis. Some amateur collectors send in their entire collections to be placed on exhibit, while
some may send only one specimen to be displayed, with the hope that it will be unusual enough to capture first prize against another's entire display. Visitors who are fortunate enough to see one of these exhibits not only are amazed at the splendor and beauty, but also are equally amazed that this is the work of amateurs.

Only the diamond is now beyond the reach of the amateur lapidists, but the substitution of zircon and clear rock crystal have helped to satisfy the majority in their desire to give a simple stone, clear as water, the sparkling beauty of a star.

Never in all history have people had the opportunity that exists today for the expression of their artistic ability through the creation of a glowing, perfect gem stone.
CHAPTER III

THE STUDY

The data received from secondary schools, colleges and universities, and mineralogical societies are included in this chapter in classified form. Letters received from amateur lapidists, teachers of lapidary work, and leaders in the field of handicrafts who have a knowledge of lapidary work are either printed in full or direct quotations are taken from them and placed in this chapter. While there are too many letters to include them all, others have been selected and placed in Appendix C of this study.

Four different questionnaires were used in collecting the data used in this chapter. Copies of these questionnaires are included in Appendix B of this study. The tables used throughout this chapter will follow the order in tabulating results as indicated in Table II.

The questions were selected for these questionnaires with the view in mind of obtaining an accurate description of lapidary work. Ample space was provided for comment, and many took advantage of it.

In order that the attainment or rejection of the stated purposes of this study may be more clearly seen, answers from all four types of questionnaires applying to a certain purpose have been grouped together, followed by relevant
TABLE II

Comparison of Returns of the Four Questionnaires

<table>
<thead>
<tr>
<th>Form</th>
<th>Type of Questionnaire</th>
<th>Mailed</th>
<th>Returns</th>
<th>Percent of Returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Questionnaires to secondary schools now teaching lapidary work</td>
<td>27</td>
<td>25</td>
<td>93%</td>
</tr>
<tr>
<td>B</td>
<td>Questionnaires to secondary schools not teaching lapidary work</td>
<td>29</td>
<td>21</td>
<td>72%</td>
</tr>
<tr>
<td>C</td>
<td>Questionnaires to colleges and universities teaching lapidary work</td>
<td>32</td>
<td>21</td>
<td>66%</td>
</tr>
<tr>
<td>D</td>
<td>Questionnaires to mineralogical societies</td>
<td>34</td>
<td>29</td>
<td>85%</td>
</tr>
</tbody>
</table>

Number of Questionnaires sent out 122 96 79%
To Determine whether Lapidary Work should be Offered in the Industrial Arts Courses.

TABLE III

Showing the Desirability of Teaching Lapidary Work on the Secondary School Level

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Yes %</th>
<th>No %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 10</td>
<td>In states that have an abundance of mineral wealth, do you think that lapidary work should be one of the courses offered in the crafts field?</td>
<td>24 96% 1 4%</td>
<td></td>
</tr>
<tr>
<td>B 1</td>
<td>Do you think lapidary work would be a desirable course to offer in the crafts shop?</td>
<td>20 95% 1 5%</td>
<td></td>
</tr>
<tr>
<td>B 4</td>
<td>Is the school administration in favor of lapidary work being taught in the industrial arts program? If not, could you give two or three reasons?</td>
<td>15 71% 6 29%</td>
<td></td>
</tr>
<tr>
<td>C 1</td>
<td>In your opinion, do you think lapidary work would be a desirable course to offer in the industrial arts program of our secondary schools?</td>
<td>17 81% 4 19%</td>
<td></td>
</tr>
<tr>
<td>D 1</td>
<td>In your opinion, is there a need for training young men and women of junior and senior high school ages in fundamental skills of lapidary work from the hobby viewpoint?</td>
<td>24 83% 5 17%</td>
<td></td>
</tr>
<tr>
<td>D 2</td>
<td>Do you believe pupils would derive any benefit from taking a course in lapidary work in high school?</td>
<td>24 83% 5 17%</td>
<td></td>
</tr>
</tbody>
</table>
In Question B - 4, instructors answering no gave the following reasons why the school administration was not in favor of such a course:

1. Lapidary work could never be a part of general education.

2. Too difficult to find qualified teachers.

3. Our industrial arts subjects are a part of general education. We attempt to teach skills and related information that will contribute to well-rounded citizenship.

4. Added expense.

The Northwest Federation of Mineralogical Societies, Seattle, Washington, stated in part:

"Those interested in stones and gems do not become delinquents. Courses have been included in Y. M. C. A. classes. Such a course is being given at the public night school."

The Southern Washington Mineralogical Society, Longview, Washington, wrote:

"Lapidary work is only fully appreciated when associated with some understanding of mineralogy and gemology along with various phases of geology. We are firmly convinced that a course in lapidary work and its applications would be excellently received as it already has taken its place in this country as a major hobby."

Table III shows that high school instructors, college instructors, and mineralogical societies are strongly in favor of a course in lapidary work for our secondary schools.
# Table IV

**Shows Comparative Value of Lapidary Work on Junior and Senior High School Levels**

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Jr. H.S. %</th>
<th>Sr. H.S. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 11</td>
<td>In your opinion, what is the comparative value of lapidary work on the junior and senior high school levels? Check one in each column</td>
<td>11 44%</td>
<td>20 80%</td>
</tr>
<tr>
<td></td>
<td>Excellent</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Good</td>
<td>8 32%</td>
<td>5 20%</td>
</tr>
<tr>
<td></td>
<td>Poor</td>
<td>1 4%</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Should not be offered</td>
<td>5 20%</td>
<td></td>
</tr>
</tbody>
</table>

William T. Baxter, who has written several books in the field of handicrafts and who for several years has been teaching jewelry gem cutting and metalcraft at Woodrow Wilson High School, Washington, D.C., felt that the section on junior high schools in this question should have been broken down into the separate grades. It is his opinion that ninth grade students could handle the work well, whereas younger pupils could not. This may account for the fairly high percentage of those who do not believe that lapidary work should be offered on the junior high school level.
All high schools now teaching lapidary work were highly in favor of offering lapidary work on the senior high school level.

Form A - Question 14: Please State Briefly the Degree of Success with which Lapidary Work Has Met in Your School

All high school instructors answered this question.

A few of the representative comments follow:

"Lapidary work is a recent addition to our Jewelry and Metalcraft course--about a year now--and has proven to be a most stimulating and valuable adjustment."

"The lapidary class has been in operation here for nine years. Mr. Gates Burrell is the instructor, and he knows how to set up and operate the best lap shop. As an adult class, the lapidary class is our best; the equipment is excellent and the instructor has an absorbing interest."

"This is our first semester in lapidary and due to the fact that the San Diego Lapidary Society and the San Diego Mineralogical Society have many members who need training in lapidary work the class of about 40 is enthusiastic and anxious to continue next semester. This work should very definitely be included as an elective course in the senior high schools of this state."

"This year we have merely started with one bench in one junior high school. The response has been very good. Many of the pupils get some practice at home as this locality is very gem conscious. We have plans for expansion of this work in other junior high schools and in our
adult night school as well as in high school."

"One of the best courses we have organized."

"Very high interest from seventh graders to adults. Expense and difficulty of obtaining material is only drawback."

"This course has been very popular. Some of our students are now teachers of lapidary work, and others sell their products successfully."

"Interests nearly all students who try it. All can do work satisfactorily."

Answers to all questionnaires indicated that a high degree of success was obtained in lapidary classes.

**TABLE V**

**Shows Why Lapidary Work Has Never Been Included**

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Reason</th>
<th>No. %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 2</td>
<td>Is there a definite reason why lapidary work has never been included in your present crafts shop program? If so, please state this reason.</td>
<td>No instructor</td>
<td>6 28%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of space</td>
<td>7 33%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No demand</td>
<td>1 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Lack of funds</td>
<td>1 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Too specialized</td>
<td>3 15%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Shop used as a clearing house</td>
<td>1 5%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>No comment</td>
<td>2 9%</td>
</tr>
</tbody>
</table>
Lack of space and a qualified instructor seem to be the predominant reasons why lapidary work has never been included in many schools.

Dr. Ivan H. Crowell, Director of Handicrafts, Department of Industry and Reconstruction, Fredericton, New Brunswick, made the following statements regarding the value of lapidary work:

"By all means, I feel that lapidary work in the secondary schools and in adult education programmes would make a most excellent project.

We are beginning to get underway here in New Brunswick. I feel very strongly that lapidary work for boys and girls would be particularly appealing."
B. To Determine Trends of Lapidary Work.

**TABLE VI**

<table>
<thead>
<tr>
<th>Form Qn.No.</th>
<th>Question</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 9</td>
<td>In your locality, has there been an increase in interest shown in lapidary work?</td>
<td>24</td>
<td>96%</td>
<td>1</td>
<td>4%</td>
</tr>
<tr>
<td>B 3</td>
<td>Do you expect to add lapidary work to the crafts work in the near future?</td>
<td>12</td>
<td>75%</td>
<td>4</td>
<td>25%</td>
</tr>
<tr>
<td>C 4</td>
<td>Has there been a definite increase of interest in lapidary work within your school in the past three years?</td>
<td>9</td>
<td>53%</td>
<td>8</td>
<td>47%</td>
</tr>
<tr>
<td>D 5</td>
<td>Has there been a definite increase of interest in the field of lapidary work in your locality in the past few years?</td>
<td>28</td>
<td>97%</td>
<td>1</td>
<td>3%</td>
</tr>
</tbody>
</table>

Five instructors failed to answer question three of Form B. Four college instructors failed to answer question four of Form C.

The following comments are examples of the prevailing opinions stated on the four types of questionnaires. They explain further the trends of lapidary work in various localities.
"Pupils know nothing about rocks or minerals and of course know nothing of gems and gem cutting. They never knew that you could take an ordinary-looking stone and get a lovely gem from it."

"At the present time, there are no lapidary classes in the San Francisco School district. However, I am setting up a shop to be opened in the near future under the Adult Education Program—-.

"Sustained interest for nine years."

"The course in Gem and Precious stones was offered for the first time here at Brooklyn College last fall in the Adult Education Division."

"--The greatest increase of interest has been among amateur mineral collectors, young and old."


"It is now estimated that there are some 800,000 persons doing lapidary work as a hobby in the U. S. A. Most of them belong to mineral and Earth Science Societies.---The handiwork of the individuals in the lapidary art are displayed at conventions.---The 1947 convention that was held in Seattle, Washington, was one of the greatest displays of lapidary art ever shown in this country, and some 15,000 persons attended and viewed the displays.

"Many or most of the mineral societies would be willing to sponsor and help the high school classes in getting started.

"There are many junior groups affiliated with the mineralogical societies and many of these young people are doing excellent work of collecting and displaying minerals as well as cutting and
polishing gem stones.

"Many splendid collections built by amateur lapidary hobbyists are in some of our largest museums and schools throughout the U. S. Our civilization and our very lives are dependent on minerals, and the study of them is essential to everyone."
- Opalene Mineral Society, Marsing, Idaho

It would seem from the results shown in Table VI and from the above representative comments that interest in lapidary work is definitely increasing.

C. To Determine Interest of Teachers in Learning Lapidary Work.

TABLE VII

Shows Teacher Interest in Taking a Course in Lapidary Work

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Yes %</th>
<th>No %</th>
</tr>
</thead>
<tbody>
<tr>
<td>B 5</td>
<td>Would you be interested in broadening your industrial arts background with a good course in lapidary work, if such a course were made available to you?</td>
<td>16 76%</td>
<td>5 24%</td>
</tr>
</tbody>
</table>

Mr. J. J. Brown, Director of Vocational Rehabilitation for Texas, states that the State Board of Vocational Education is highly interested in finding teachers trained in lapidary work for their high schools.
Other comments were:

"Very little has been done in the East to show the importance or to promote an interest in this field."

"A number of teachers here would like to receive training."

"Lapidary work has been my hobby for the last six years, and I am greatly enthused about it. All my knowledge of the subject has been gained through experience and the trial and error method."

From comments made on the questionnaires, it would appear that one of the reasons for the disinterest on the part of some teachers is the lack of knowledge about lapidary work. Even so, the majority of teachers who do not now teach lapidary work indicated an interest in taking such a course.

D. To Determine the Length of Time Devoted to Lapidary Work

TABLE VIII

Shows Number of Hours Per Semester Devoted to Lapidary Work

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>200 180</td>
<td>90</td>
<td>75</td>
<td>40</td>
</tr>
<tr>
<td>A 2</td>
<td>What is the length of your course in lapidary work in hours per semester?</td>
<td>3 1 2 2 1 16</td>
<td>127.7</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Sixty-four percent had no answer for this question. However, several noted along the side of the question that there was no way of answering it, since the work was offered in connection with jewelry work or in the craft classes in their schools.
E. To Determine the Cost of Lapidary Equipment

TABLE IX

Shows Amounts Spent on Lapidary Machinery

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>No. of Schools</th>
<th>Amount Spent</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 4</td>
<td>Estimate the cost of your lapidary machinery to the nearest figure.</td>
<td>2</td>
<td>$50</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>$75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>$100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>$150</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>$200</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>$250</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5</td>
<td>$300</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>$500</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>$700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>$750</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>$1000</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>$3000</td>
</tr>
</tbody>
</table>

Average Amount Spent on Machinery $404

Schools that had spent over $300 on their lapidary machinery were the schools which offered lapidary work as a separate unit. Seventy-six percent of the schools spent $300 or less on their lapidary equipment.
F. To Determine the Number of Students That Are Accommodated in Present Courses in Lapidary Work.

TABLE X

Shows Numbers of Pupils Lapidary Machines Will Accommodate at One Time

<table>
<thead>
<tr>
<th>Form Qn.No.</th>
<th>Question</th>
<th>No. of Schools</th>
<th>No. of Students</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 3</td>
<td>What number of students can you accommodate at one time on the lapidary machines?</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>6</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>10</td>
</tr>
<tr>
<td></td>
<td></td>
<td>3</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>1</td>
<td>20</td>
</tr>
</tbody>
</table>

Average Number of Students Accommodated 6

Four schools left this question blank.

Many schools felt there was no need for a large lapidary setup as their courses were combined with the jewelry or handicrafts class. As a consequence, it would be necessary for only a small number of students to use the machines at any one time.
G. To Determine the Sources of Material.

TABLE XI

<table>
<thead>
<tr>
<th>Question</th>
<th>Percentages</th>
<th>Av.</th>
<th>Form Qn. No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>What percent of the gem-cutting material do you purchase from supply houses? Use nearest %</td>
<td>5 7 0 6 2 3 2 28</td>
<td></td>
<td>8</td>
</tr>
</tbody>
</table>

Of the two schools who purchased all their cutting material from supply houses, one located in the city of Los Angeles found it impossible to make a 300 to 400 mile field trip in one day with a large group of students. The other, located in Washington, D. C., stated that the surrounding territory had no gem-quality minerals to make organized field trips profitable.

Ten percent of the schools stated additional material was purchased to get samplings of minerals from other states, as they had no connections for cross-country trading.
### TABLE XII

**Shows Other Sources of Gem-Quality Minerals**

<table>
<thead>
<tr>
<th>Form Qn.No.</th>
<th>Question</th>
<th>Yes %</th>
<th>No %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 7</td>
<td>Are organized field trips used as a part of the work in your classes?</td>
<td>7 28%</td>
<td>18 72%</td>
</tr>
<tr>
<td>D 4</td>
<td>In your area, are there enough deposits of gem-quality minerals to make field trips desirable and practical for a high school class in lapidary work?</td>
<td>24 82%</td>
<td>5 18%</td>
</tr>
<tr>
<td>D 6</td>
<td>Do you feel that cross-country trading of gem-quality minerals by secondary schools would be practical and desirable?</td>
<td>22 75%</td>
<td>7 25%</td>
</tr>
</tbody>
</table>

Form A - Question 7 shows that only 28% of the schools have organized field trips to collect their gem-cutting material, whereas 82% indicated on Form D - Question 4 that deposits of gem-quality materials were available. Ten percent of the schools stated the reason for not having organized field trips was that a wealth of material was brought in by pupils who went on trips of their own, thus making organized field trips unnecessary.
H. To Determine the Content of a Course in Lapidary Work.

TABLE XIII

Shows Contents of a Course in Lapidary Work

<table>
<thead>
<tr>
<th>Form Qn.No.</th>
<th>Question</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A 13</td>
<td>Do you include faceting in your lapidary work?</td>
<td>8</td>
<td>32%</td>
<td>17</td>
<td>68%</td>
</tr>
<tr>
<td>A 15</td>
<td>Do you think an organized course of study for lapidary work is practical?</td>
<td>23</td>
<td>92%</td>
<td>2</td>
<td>8%</td>
</tr>
<tr>
<td>C 6</td>
<td>Do you include faceting as one of the areas in your lapidary work?</td>
<td>9</td>
<td>60%</td>
<td>6</td>
<td>40%</td>
</tr>
</tbody>
</table>

On Form C - Question 6, six colleges did not answer this question. Five of the six colleges who answered no indicated that they would include faceting within the near future. The remaining college which answered in the negative taught faceting in description but not in practical application.

There were several reasons why high schools offering lapidary work included no faceting. Some of these are:

1. Lack of technical knowledge by instructor.
2. Additional expense in obtaining good faceting heads.
3. No suitable minerals for faceting in their locality.
4. Not practical in their shop setup.
For comment on Form A - Question 15, 10% of the schools felt that due to the nature of this highly specialized type of craft a series of instruction sheets with special projects should be presented to students, as many of them will eventually set up their own equipment at home and carry on this work as a hobby and for additional income.

Form A - Question 7 and Form D - Question 4 in Table XII on organized field trips might also be considered a part of the content of a course in lapidary work.

I. To Determine on What Basis Lapidary Work Should Be Offered in the High School.

TABLE XIV

Showing Bases on Which Lapidary Work Could Be Taught

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Yes</th>
<th>%</th>
<th>No</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Is lapidary work taught as a special course in your school?</td>
<td>9</td>
<td>36%</td>
<td>16</td>
<td>64%</td>
</tr>
<tr>
<td>C</td>
<td>Do you think lapidary work could be taught successfully as a separate course within the crafts field? If the answer is No, would you please state your reason.</td>
<td>16</td>
<td>94%</td>
<td>1</td>
<td>6%</td>
</tr>
<tr>
<td>D</td>
<td>Do you think lapidary work too expensive for the average person to have as a life-long hobby?</td>
<td>6</td>
<td>27%</td>
<td>23</td>
<td>73%</td>
</tr>
</tbody>
</table>
In Form A - Question 1, of the 64% who answered no, 28% stated lapidary work was offered in connection with the jewelry class, and 36% stated it was offered in connection with the handicrafts class.

The one college which answered no on Form C - Question 3 stated lapidary work was too specialized to offer to students of secondary schools. Four colleges did not answer the question.

Orange Coast Mineral and Lapidary Society, Corona Del Mar, California, stated:

"In our opinion there isn't any hobby that can surpass the lapidary and mineral interest. We believe that some instruction in mineralogy and gemology should accompany any instructions in lapidary. In that way, values of materials are learned and the desire to get in the field and collect your own is fostered."
J. To Determine on what Basis Lapidary Work is Offered in the Colleges.

**TABLE XV**

Shows Purposes of Teaching Lapidary Work on the College Level

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>a %</th>
<th>b %</th>
</tr>
</thead>
</table>
| C 2          | In your college, is lapidary work offered for: a. appreciation and personal enjoyment; or b. as a craft course preparatory to teaching in the industrial arts or other fields. | 6   | 46% | 3   | 23%

Percentages are based upon the thirteen colleges that answered the question. Of the four schools not included in the table, three, or 23%, indicated that they taught lapidary work for vocational purposes. One college, or 8%, checked both a and b. Eight colleges failed to answer the question.
### TABLE XVI

**Shows Objectives of Lapidary Work on the College Level**

<table>
<thead>
<tr>
<th>Form Qn.No.</th>
<th>Question</th>
<th>No. of Colleges</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>C 5</td>
<td>List three or four objectives which you expect to obtain by offering lapidary work on the college level.</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Leisure time pursuits</td>
<td>6</td>
<td>29%</td>
</tr>
<tr>
<td></td>
<td>Relationship with science</td>
<td>10</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td>Basic skills for teaching</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>Exploration</td>
<td>12</td>
<td>57%</td>
</tr>
<tr>
<td></td>
<td>Training for professional work</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td></td>
<td>No statement</td>
<td>6</td>
<td>29%</td>
</tr>
</tbody>
</table>

It is interesting to note that two of the reasons checked indicate that over 50% of the colleges teach lapidary work from the hobby standpoint, whereas only 14% teach it from the standpoint of training instructors.

**Form C - Question 7: What Is Your Opinion of the Value of Lapidary Work as a Hobby?**

Following are a few representative comments:

"Good - restful - encourages outdoor search for good minerals."


"Fascinating work for young and old. It has many appeals. The mechanical-minded can make equipment, the artistic can create, the naturalist can look for stones."

"I believe it would have considerable value, would serve a large number of people and would direct their interest toward the aesthetic."

"It is enjoyable and interesting as well as educational. The zeal of lapidary hobbyist is as intense as other hobbyists and more so than most."

"Very little."

"Excellent—it gives outdoor exercise and inside hobby work."

"An excellent hobby. There are many shops here in El Paso in homes of people."

Ninety-four percent of the colleges that answered this question considered lapidary work highly desirable as a hobby. Six percent considered it poor. Three colleges did not answer the question.
K. To Determine Whether Lapidary Work Should Be Included in Adult Education.

TABLE XVII

Shows the Values of Teaching Lapidary Work in Adult Education Classes

<table>
<thead>
<tr>
<th>Form Qn. No.</th>
<th>Question</th>
<th>Yes %</th>
<th>No %</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Do you offer lapidary work in adult education classes?</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>A</td>
<td>Do you think lapidary work should be included in adult education classes?</td>
<td>25</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>Would a course in lapidary work fit well into adult education?</td>
<td>20</td>
<td>1</td>
</tr>
<tr>
<td>D</td>
<td>Would it be desirable in your community to offer a course in lapidary work as one of the classes in adult education?</td>
<td>25</td>
<td>4</td>
</tr>
</tbody>
</table>

While only 52% of the high schools now teaching lapidary work offered it in their adult education classes, 100% of them thought the course should be offered.

The one college that answered No on Form C - Question 8 stated the work required too much skill to be done in spare time. The colleges that answered Yes made statements similar to the following:

"Yes. It requires no previous related training to get started, yet there is no limit to the field of study.. Those..."
who wish can stop at any level."

"I believe it would fit here as well as any place."

"Yes. As a matter of fact, such a course is offered here at Brooklyn College, only in the Adult Education Division."

"Definitely yes!!"

The West Coast Mineral Society, Fullerton, California, stated:

"I was enough interested in the idea that I took the trouble to make inquiry of seven different high schools and two junior colleges. And I took it up with our mineral society on the evening of Feb. 10th.

"None of the junior or senior high schools were interested, although they all thought it all right to have in adult night school courses. I also took the questionnaire to two mineral dealers, and they both thought it should be in the adult group. There would be nothing to prevent any youngster from attending night school if he is sufficiently interested.

"No one can educate a hobby into a child. Children may be temporarily interested as they are in many things. But as lapidary equipment is costly and easily damaged, it should be used only on people who will take care of it."

The Snohomish County Mineral Society, Everett, Washington, stated:

"To back up the answers I have given to this questionnaire, I would like to state that in the past three years the Snohomish County Mineral Society has helped sponsor several night classes, one was crystallography and minerals, with an average attendance of 30. A class in
jewelry making limited to 15 and a class in lapidary work with approximately 40 enrolled. These classes were held at the Everett Junior College."

Mr. James L. Kraft, Chairman of the Board of the Kraft Foods Company, who has long been an amateur lapidist, had the following statement to make about offering lapidary work in adult education classes.

"I think if the public schools could open such a department for grown people who wish to pursue a hobby, who like the outdoors, and some of whom might develop into real high class workmen, that would be rendering a marvelous service to the community."

TABLE XVIII

Shows High School Instructors' Ratings of Lapidary Work on the Adult Level

| Form Qn. No. | Question                                                                 | Ex. % | Gd. % | Poor
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Should not be offered</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A 12</td>
<td>In your opinion, of what value is lapidary work on the adult level?</td>
<td>22</td>
<td>88%</td>
<td>12%</td>
</tr>
</tbody>
</table>

One hundred percent of the schools thought that lapidary work would be either a good or an excellent course to offer in adult education classes.
CHAPTER IV

SUMMARY AND RECOMMENDATIONS

Summary

The resulting conclusions from the attempt to solve the problem of teaching lapidary work on the secondary school and adult school level are listed here, not as unquestionable facts, but as statements that show the actual outcome of this study, which has been based on sources of information that are fairly dependable.

1. Data gathered from questionnaires give evidence that lapidary work is being taught in many of our secondary schools with a very high degree of success.

2. The data also indicate that the demand for such a course as lapidary work is increasing rapidly in many sections of the country east of the Mississippi River and in nearly all sections west of the Mississippi River..

3. Secondary schools, colleges and mineralogical societies are decidedly in favor of instruction in lapidary work being offered in the secondary and adult schools of the country..

4. The survey indicated no schools suffered difficulty in adapting lapidary work to the secondary level due to its technicalities.
5. Data gathered from the questionnaires give evidence that the cost of a lapidary setup is well within the means of any secondary school, limited only to the uses to which the lapidary equipment is to be subjected.

6. The study shows that the course content in the majority of schools teaching lapidary work is offered on an exploratory basis only.

7. The statistics indicate that field trips should be included as part of the course in lapidary work in schools that have an abundance of mineral wealth in the surrounding territory.

8. For those schools wishing to keep expenses at a minimum, results of the survey suggest that lapidary work should be taught in connection with the jewelry or handicrafts class.

9. The survey definitely indicated that lapidary work should be taught only in connection with leisure time pursuits and not as a vocational subject in the secondary schools.

**Recommendations**

The following suggestions which arose from this study are offered here with the intention of enriching either the jewelry or handicrafts classes in the industrial arts program of the schools in our country.
1. It would seem that the inclusion of lapidary work in the industrial arts program would prove profitable for all secondary schools that have an abundance of mineral wealth in their surrounding territory, both as an exploratory course and as an aid in the development of a worthwhile hobby, for pupils as well as adults.

2. As a means of assisting experienced teachers and preparing new teachers, the teacher-training institutions should develop in their handicraft or jewelry making classes a good program of instruction in lapidary work, with ample time to study the basic techniques of faceting in preparation for teaching such work on an exploratory basis in the industrial arts departments of the country.

3. Schools which do not have an abundance of mineral wealth in their surrounding territory or which are located in highly populated areas should carefully consider the inclusion of such a course as lapidary work in the handicrafts or jewelry classes, since minerals of gem quality are easily acquired through supply houses at nominal prices.
BIBLIOGRAPHY


APPENDIX A

Suggested Setup of Lapidary Equipment and Description of Activities
Chatelaine, ear rings, ring and pendant, set with matched Mojave bloodstone.

This particular type of bloodstone comes from the Leadpipe Springs district on the Mojave Desert. There are only a few lapidists who know the exact location of this particular type of jasper. Unlike the jasper that comes from India with its small flecks of red on a deep green background, this semi-translucent mineral has large clots of red on a deep green background.
INTRODUCTION

The purpose of Appendix A is to help the handicrafts instructor set up a small lapidary layout in his department, with the basic information needed to develop this relatively new and rich field to the best advantage in his locality. In past teaching experience, the instructor may have found many students who have brought in handsomely colored stones, and he wished that he could help them in some way to enhance and to perpetuate the beauty of these stones.

Lapidary work is a fascinating craft and has many features to recommend it. Equipment is quite simple and inexpensive, no great skill is needed to start, and through practice one can produce work that will lead to perfection. It is work that can be interrupted at any stage without injury to the job in hand, and one that can develop quite easily into a lifelong hobby.

It is a craft at which girls do equally as well as boys, and a teaching medium that does much in encouraging students to discover what else old Mother Earth has hidden within her bosom.
COLLECTING GEM MATERIAL IN THE LOCALITY

The first discovery of gems in a region, like that of gold, is usually made in the beds of streams. Often it is in the search for gold that gems of value are found. Diamonds in Brazil, sapphires in Montana, and rubies in North Carolina were discovered in this manner.

The frequent occurrence of gems in the beds of streams and along the sea shore is due to the fact that the gem minerals are usually harder and less easily decomposed than the other minerals of the rocks in which they were formed. They remain after the mother rock has disintegrated and its constituents for the most part removed. The chance of discovery in a stream bed is further facilitated by the enhancement of their color when wet, causing them to be seen more easily. Stream beds tend to group together minerals of the same specific gravity, thus causing a concentration of the gem minerals. A stream bed is a good place to start looking for gem quality minerals. Beds of old streams are good places to search, with the exception that the color of the stones will not be so obvious.

The gravel of sand pits and rocky slopes of hilly country are ideal places to look for agates and forms of jasper. The latter will occur in greater abundance around old lava flows or old volcanic mountains or mounds.
The beaches of lakes also afford places for the gathering of gems. Since quartz is so abundant, rare indeed is the county in the United States that does not have some form of it that will be suitable for display purposes after it has been polished.

Each state has a bureau of mines, and from time to time maps and reports on mineral formations are issued, together with masses of data pertaining to the subject of gems and minerals. These papers may be purchased at a nominal cost.

The United States Government maintains an elaborately equipped department devoted to the subject of minerals of all classes. A letter addressed to the Superintendent of Public Documents, Washington, D.C., will bring information.

Further information may be gotten from any local lapidist in the community. If he has been engaged in the art long, and if there is gem quality mineral in the vicinity, he certainly will know of its whereabouts.
EQUIPMENT FOR GEM CUTTING

Selecting and building the proper equipment for gem cutting and polishing is of great importance to the instructor who plans on teaching lapidary work. There are many problems he must take into consideration, such as space, amount of funds, number of students to each class, and whether he plans on teaching it as a separate unit or decides to include it with the art metal and jewelry work. Whatever his problem may be, if he has properly organized his course, built and set up his equipment to the best advantage, the lapidary unit can be worked into any industrial arts department with tremendous success.

The selection or construction of good equipment is very important to the lapidary setup. Many an amateur lapidist will brag of doing excellent work on an outfit for which he paid one-tenth of the amount that his neighbor paid for a machine similar to it. For a time, the cheaper machine or tool will do fair work, but it will not give the number of years of service one expects of a machine in the industrial arts shop.

Considerable research has been done on equipment and supplies for the lapidary setup, but it should be understood that the following recommendations for equipment are by no means the final word. However, great success has been realized with the equipment and ideas expressed.
throughout this chapter. They represent the opinions of amateur and professional lapidists who have had many years of experience.

Listed on the next few pages are the tools, abrasives, machines and materials needed for 25 pupils in a lapidary course planned in conjunction with a handicrafts or art metal and jewelry class, and suggestions for setting up the equipment. At no time are there to be more than seven pupils working with the lapidary machinery. Any greater number than this will cause the pupil to try to speed up the processes he must go through and will lead to inferior or ruined work, besides a loss of valuable time.

**Equipment and Sources of Supply**

1. One heavy duty grinding arbor (double-sealed self-lubricated ball bearings. 3/4" shaft.)

   The housing completely covers the pulley. Cast aluminum alloy having tensile strength of 22,000 lbs. per sq. inch. Will mount 10 x 1½ or smaller wheels. There are 16" between inside of wheels, which allow ample working room. This arbor is designed especially for lapidary use.

   **Price:** $25 - $30

   **Address:** Greighers, Pasadena 4,

   California
2. Grinding Wheels (two)
   a. Silicon carbide 1\(\frac{1}{2}\)" x 10"
      Code 37, Grit 120, medium grinding "K".
   b. Silicon carbide 1\(\frac{1}{2}\)" x 10"
      Code 37, Grit 220, medium grinding "K".
These two grit-size and bond-type grinding wheels are
the ones most frequently used in all lapidary shops for
grinding minerals under 9 in hardness. The 1\(\frac{1}{2}\)" thickness wheel gives much longer wear with little more cost
than the 1" thickness wheel.
The grinding wheels will receive the greatest amount of
wear in the lapidary shop. It is highly recommended
that abrasive wheels not under 10" in diameter be
selected.

3. Wheel Dresser
No suggestions need to be offered as far as selection
of a wheel dresser is concerned. This may be safely
left to the discretion of the instructor, but it is of
the utmost importance for the instructor to keep the
grinding wheels running true and even at all times for
superior work in rough-shaping stones.

4. Splash pan setup for grinding unit
   See Drawing 1, page 78

5. Cut-off Saw
The cut-off saw is an 8" diameter diamond saw that saves
the lapidist much time in grinding and reduces the waste
This drawing is to give the instructor some idea of the method of setting up proper splash pans for the 10" grinding wheels. An outstanding feature of this arbor is that it has a grit slinger mounted on the inside of each wheel, keeping the bearings protected at all times.

The splash pan is made of 16 or 20 gage sheet metal, with a cloth drip pad fastened to the upper inside of the drip cover to prevent the wheel from splashing water. The bottom part of the pan is made long enough so that the worker can rest his arms on a small border platform of wood to steady his hands. The platform should be well in front of the wheel, to allow free play of the hands before the wheel. The pan is filled with about 1" of water, and a sponge placed under the wheel to keep it wet at all times while grinding.

Each of the splash pans is a complete unit by itself.
of slab material purchased from lapidary shops. It quickly trims a slab or cuts through small stones of 2" in diameter. Although this latter procedure is widely used, it is not recommended for stones of larger size, since it wears out the cut-off saw blade rapidly. All minerals of large size picked up in the field should be test sawed on the regular diameter saw which has a clamp to hold the stone solid and to feed it into the saw at a uniform sawing speed. The cut-off saw can be purchased in a complete unit, although it is cheaper to purchase a small arbor with a shaft 5/8" in diameter. The unit is easily built, using only 3-ply wood. A suggested setup is offered in Drawing 2, on page 80. Such an arbor can be purchased from a local hardware dealer at a nominal cost and will give many years' good service.

6. Sanding Unit

The sanding procedure is one of the most important steps in the polishing of a cabochon. When the stone has been given its final shaping on the grinding wheels, the preparation of the stone to take the proper polish is by far the most difficult of all processes. On the sanders all scratches must be removed from the stone before it will take a high polish. Here again, the sanding unit can easily be built within the shop. The purchase of arbors for the unit will not be necessary for the
For Sawing of Slabs and Small Stones

Drawing 2

There is no exact size that the cover splash pan must have. The drawing above shows the approximate size it can be in relation to the 8" diamond charge blade. The slab or specimen to be sawed is held against the movable slide with the fingers and slowly fed into the saw as one might use a push stick on an arbor saw. The table on which the slide rests should be at a 15° angle. This helps the saw pull the stone into the blade by frictional drag, thus requiring little pushing. The speed of the saw should be about 1200 RPM, running in fuel oil. The top cover is on a hinge, so it may be lifted up to change blades.
instructor may use wood lathes and mount the sanding disks on face plates.

The sanding unit should be arranged so that two pupils can work at the same time in two different stages of sanding. If the shop has two wood lathes, no other arbors are needed. All sanding and polishing can easily be accomplished on them by quickly switching disks for different stages of sanding.

Drawing 3 on page 82 is a suggested setup for a sanding unit.

7. Sanding Paper

Sanding sheets come in many different grits on cloth which can be run wet or purchased with regular paper backing. Although the cloth-backed sanding paper will last longer, it is not the most desirable to use in the shop if the teacher is trying to cut down on expenses. Through experience in using both types, it was found that with proper care the paper backing will last nearly as long as the cloth, or "Speedwet" sanding disks, as the latter are sometimes called, and they will average about one-half the price. Many lapidists use the "Speedwet" abrasives, and when the surface of the cloth has been broken down too far for proper sanding, they recharge it and continue to use.

Purchasing abrasives directly from the companies instead of relying upon local purchase will save from one-third
The one-view drawing above is the most practical set up in the high school shop for sanding purposes. Two students can work at the same time in two different stages of sanding a stone. With a one-surface grinder only, it would be necessary to replace sanding disks each time a certain stage in preparing the stone for its final polish was reached.

The sanding disks are made of wood 1" thick and not over 6" in diameter. A metal rim is best to use for holding the sanding cloth smooth and firm over the slightly convex surface of the disks. The reason for such a small disk is economy in the use of silicon carbide cloth and paper sheets. A 6" disk, sanding on the vertical, will do just as good a job for cabochons as a 12" disk.

The face of each disk has a felt pad glued to the surface to act as a cushion to eliminate vibrations or bumping the stone when holding it against the disk.

A small arbor with a 3-speed pulley for different speed adjustments will do quite well.
to one-half the cost.
Many lapidary supply companies may try to sell a quire
of disks in each grit which they have in stock. Later,
one may find that there are three or four different
grades which are seldom, if ever, used. For simple and
speedy sanding procedures, abrasives are needed in 120,
220 and 500 grits only. The directions for sanding
procedures on page 103 explain the reason for the large
jump between grits when sanding a stone.

8. Abrasives in the Bulk
Abrasives can be purchased in the bulk through supply
houses or directly from the abrasive companies. The
latter is the far cheaper method. They are purchased
by the pound, specifying grits. Abrasives purchased
this way are almost always for use on the laps or dril-
ling compounds. Three or four different grit sizes
are all that are needed, instead of the seven or eight
which many companies advise.
There are actually two distinct types of abrasives on
the market, one of which will serve the purpose. This
is silicon carbide, which will cut all minerals through
the hardness of eight very satisfactorily. This abra-
sive is the most widely used for all lapping jobs and
is inexpensive. Norbide abrasive should not be pur-
chased unless it is intended for work on minerals
between the hardness of eight and nine. Norbide
abrasive is the hardest of all known manufactured abrasives and is two to three times more expensive than silicon carbide. It will cut no faster than silicon carbide on minerals up to eight and the completed job is no better.

If a lap is used, bulk abrasives should be purchased in 80, 120, 220 and 500 grits. These four grits will do a fine job of preparing large, flat specimens for the final polish.

9. Polishing Powders

During the last war, an all-out effort was made to find a polishing powder that would do the job much faster than tin oxide, which had been the old standby for a number of years. Through experiments, the rare cerium oxide groups were given several tries. The result was the development of a polishing powder much better than tin oxide. This was named cerium oxide, and today it is by far the most efficient polishing powder for stones up to the hardness of nine on the Mohs' Scale.

Cerium oxide is more expensive than tin oxide, but it goes twice as far and will polish some minerals with nearly four times the speed of tin oxide. For the school shop, cerium oxide will save a great deal of time on the polishing buffs, although the cost is somewhat higher. Cerium oxide can be purchased from any lapidary supply house.
10. The Horizontal Lap

The horizontal lap is one item of equipment that will not be needed if the instructor intends to go no farther into lapidary work than the cutting and polishing of cabochons. However, the lap is necessary if large, flat specimens of minerals are to be sanded and polished. If the instructor intends to use the lapidary installation in the art metal and jewelry class, it is best for him to omit the lap until the time when he may decide to expand the size of his lapidary course. Laps come in many different sizes, and the size to get depends upon the intended use. For faceting, a lap of 6" to 8" in diameter is the size most commonly used. For flat cabinet specimens, the 12" or 16" lap should be procured, the latter being probably the most widely used. One of the best laps on the market is made by the "Covington Lapidary Engineering," Redlands, California. This 16" lap, a complete unit, does not have a perfectly flat surface but is slightly concave, so the flat specimen sanded on the concave lap will itself have a convex surface, which makes it much easier to give the final polish. This convex surface cannot be seen with the naked eye. Optical companies throughout the country use the concave lap on flat work to speed up polishing processes.
EQUIPMENT LAYOUT

In the actual arrangement of the equipment suggested in Drawing 4 on page 87, there is really no set order that must be adhered to. However, for an efficient layout and for as little confusion as possible, the machines should be spaced or arranged in such a manner that no matter at which step the student is working he will not be crowded or bumped by someone else.

From teaching experience, the following setup has been found to be the most practical. The lapidary equipment should be arranged on one table to conserve as much space as possible, and the machines should be placed in the order of the cutting and polishing process. For clarity, it is pointed out here that the sander is the place where the actual finishing of the stone is started. The greatest amount of error and ruined work will occur between the sander and the polishing wheel if the student does not take precautionary measures and see that the stone does not overheat and crack while sanding. The student also could easily ruin the stone on a buffer by overheating or by carelessly allowing grit to get on the buff. The polishing buff should be covered or removed from the arbor and kept in a clean place when not in actual use. The drawing shows the buffer in position in the equipment arrangement, but this does not necessarily mean that the buffer wheel is to
1. Cut-off diamond charged saw.

2. Grinding Unit - 120 and 220 grit wheels.
   (1 1/2" x 10")

3. 16" Concave Lap.

4. Double Sanding Unit.

5. Polishing Buff.

6. 1/2 Horsepower Motor (1800 RPM)
remain uncovered when not in use.

The layout on page 87 has proven to be most satisfactory. The small cut-off saw is first in line, to allow the student to trim his specimen before grinding.

The grinder or lap can be interchangeable. It makes little difference. The lap is not needed for cutting cabo-

chons since a smooth surface can be gotten on one side of

the specimen by holding it against the side of the grinder.

The sanding unit is next in line and should be arranged so that two can be sanding at one time and not be cramped

for room. If the unit is mounted on the table in the arrangement shown, it is much easier to get at the left sanding disk than if the unit were mounted in the center of the table.

The buff should be mounted separately if possible. The farther it can be placed from the grinding and abrasive disks, the less chance there is of contamination with grit.

The saw, grinder, lap, sander, and polishing buff can be run off the same motor, using one long shaft as shown. The buffer can have a separate motor or be connected to the shaft, whichever the instructor desires. A better setup is to have the saw on a separate motor. There is a good reason for this. The cut-off saw slings oil from the drip pan, which is used for a coolant and will need constant refilling if kept running continuously. It has happened that some students will try to cut their stones on a dry
blade rather than refill the drip pan. This will overheat and warp the blade and may fracture the specimen being sawed.

The rest of the equipment can be set up for one motor or in whatever arrangement best for the particular shop.

A good light over the grinder and sander is absolutely necessary. A poor light will result inevitably in inferior work. The light should be close enough and in such a position that no shadow falls across the specimens in the workers' hands. If possible the final process, buffing, should be under natural light.

Rubber or heavy cloth aprons should be worn by the students while working at the machines to prevent water, oil or polishing compounds from getting on their clothes.
MAIN OPERATIONS IN GEM CUTTING

Sawing

Many times the sawing of a stone in preparation for the grinding wheel is the first procedure the student must go through. There will be times when the cutting of gem stones will not be necessary if usable fragments or splinters are available. Large rocks can be broken with a hammer to obtain fair-sized specimens that will make good gem stones. However, this procedure should be discouraged as a common practice in school shops. Some very fine gem stones have been ruined by a too-free use of the hammer in testing gem specimens. Hammering merely to see what is on the inside of a rough-looking rock, without taking the time to chip off one sharp corner carefully, has resulted in the ruin of what would have been many fine specimens.

Careful consideration should be given to each piece of mineral in order to determine if it is worthy of sawing. wetting the stone will sometimes help or chipping off a sharp corner and inspecting the exposed part under sunlight. If the mineral shows possibilities, the stone should be sawed rather than cracked open with the chance of shattering a beautiful design and display of colors hidden on the inside.

The cut-off saw will save much time in the
determination of good specimens. The suggested shop-made setup on page 87 has no method of firmly clamping specimens on the slide, but with proper precaution small minerals not over 2" in diameter can very easily be sawed by holding the stone firmly against the back of the slide and feeding it slowly into the diamond saw.

With a little practice, expert work can be done on this saw, with a great deal more time saved than if a clamp were used in which to lock the specimens. When the actual sawing with the cut-off saw is begun, the pressure must be kept constant throughout the sawing. This will give a clean cut on the surface of the stone. Shifting of pressure or removing the stone before sawing all the way through will leave creases on the surface that will need either lapping down or smoothing off on the side of the grinder.

The cut-off saw actually was designed for slab sawing only. After a large specimen of quality gem material has been sawed on the 12" or 16" diamond saw into slabs 1/16" to 3/16" thick, the cut-off saw is the only saw which can be effectively used to saw these slabs into square pieces of various sizes.

During the operation of the cut-off saw, it is necessary for the operator to wear an oil-proof apron. The saw turns at a speed varying from 1000 to 1400 RPM, and the splash pan will not entirely keep the fine spray from getting on the individual at times.
Students should be allowed to practice on the cut-off saw with agate or some softer material, in order to get the technique and to feel when the diamond saw is operating correctly.

The slide on which the specimen rests is placed at a 15 degree angle above the center of the shaft of the saw. There are three main reasons for this:

1. It enables the saw to do a faster and more efficient sawing.

2. Very little pressure is needed on the stone to force it into the saw, since at this angle the action of the saw turning into the stone pulls the mineral into the blade by frictional traction.

3. The constant pressure which is automatic at this angle makes the saw wear more evenly.

There are not many rules for getting good results in the actual sawing of slabs from the larger specimens by the use of the large (14") diamond saws. Yet if one desires to saw to the best advantage of the specimen, considerable practice will be needed. Many of the factory-made diamond saws are of good workmanship and will give good service. If one is purchased, there may be points about it that are not liked after the saw has been used a few times.

For effective sawing with the large carriage saw, it is best to cover here a few do's and don'ts on the saw, along with suggestions for improvement.
If the saw that has been purchased has wooden grips in the carriage clamps, placing over the wood a 14 gage copper sheet the same size as each grip will greatly reduce slipping of a specimen in the sawing process. Wood has a tendency to break down under heavy pressure, while copper will allow the rock to dig in and hold more firmly. Also, the copper grips will last many times longer than the wooden grips.

Few of the commercial diamond saws have adequate splash curtains to protect the worker from the spray of fuel oil which is used as a coolant and lubricant for the diamond-charged blade. It is quite simple to eliminate most of this spray by the use of additional light-weight canvas as curtains.

It is recommended here to purchase a saw that has a carriage pulled forward by a weight. The weight should be around eight to ten pounds. The greater the weight placed on the pulley, the faster the saw will cut, but its life will be shortened. With the automatic feed saw, there is danger that the amateur will place a mineral with a hardness of 7 or 7½ in the feed when the saw is set to saw minerals with a hardness of 5½ to 6. As a result, a hard mineral will be forced into the saw at a greater speed than the saw is capable of handling. This may buckle the blade under the pressure or tear out the embedded diamonds.

When clamping the specimens in the feed, extreme
care should be taken to see that the mineral is firmly gripped by the jaws. This may be tested by grasping the mineral protruding out of the clamp and seeing if it can be moved under heavy pressure.

The saw should be running in fuel oil to a depth of not less than one inch at a speed of 400 to 500 RPM for a 12" saw, for economy of diamond blades.

One should not let the mineral slam up against the saw when starting, but very gently allow the saw to cut a good groove in which to rest before full pressure of the weight is allowed against the saw. With practice, one can tell just how well the saw is cutting by the sound. Just before the mineral is sawed all the way through, the worker takes a firm grip on the carriage and gradually releases the pressure as the saw comes completely through the specimen.

Giving proper demonstrations to students on the operation of the cut-off saw and the large slab saw will save many saw blades in the future. A certain amount of skill and patience must be used to do good sawing. This can be acquired only under proper instruction. Many pupils are not willing to share responsibility and should never be allowed actually to operate a large saw unless under constant supervision.

Care should always be taken to see that the diamond-charged blades are running in lubricant at all times when
sawing. If, as a result of lack of lubricant, a blade does become warped from overheating when sawing a stone, the blade can be made partially true again by laying it flat on a surface plate and slowly tapping around the inside of the blade with a small hammer, gradually proceeding toward the outside. The blade is then turned over and the process repeated. This will help put the blade back in fair condition, however it will wear out faster since it is not perfectly true.

If a blade becomes flat on one side from a bad blow or if it has a small nick, no sawing can be done until the removal of the defect. This can be remedied by sawing agate at a light pressure until the saw is true again or by clamping a piece of cast iron in the vise and slowly feeding this into the saw. Caution must be used here, since the diamonds will be torn out at a fast rate, and the results may be an uncharged saw.

Another method is to remove the saw from its spindle, place on a surface plate, standing edge up, and with a highly polished lightweight ball pein hammer slowly and lightly beat down the rim of the saw. This should be repeated three to four times around before testing the saw again by sawing a specimen.
Rough Grinding and Shaping

There is no limit to the actual variations of design in the cutting and polishing of gem stones. A person is limited only by his ability and imagination in carrying out a different design.

The rough grinder, 120 grit wheel, is the place where the shaping of the gem stone is begun. The photograph on page 97 shows gem stones that were used as a teaching aid to help pupils select sizes and shapes for gem stones. These cabochons were also designed to help students visualize a finished gem stone in a piece of raw mineral before the actual grinding processes were begun. One of the most difficult problems is to get the pupil to orient his mineral, bringing out beauty, markings and color to the best advantage by cutting into the proper shape, thickness, and size. A teaching aid of the sort shown in the photograph will be of inestimable help in getting this information across to the pupil.

Before beginning the grinding, some sort of design should be marked on the stone for the pupil to follow when cutting the stone down to shape on the 120 and 220 grinding wheels. The best method is to draw an outline of the desired shape of the stone within the limits of the slab, using a pointed aluminum wire (pencil will rub off too easily,) showing the best design and color of the slab.
This display of stones was used as a teaching aid in helping students select different designs and get correct proportions when cutting and polishing their gemstones.

IDENTIFICATION

Top Center Three (Left to right)
Moonstone, fire opal, red moss jasper

Second Row, Seven Stones
Onyx, highly agatized moss jasper, jasper, bleeding stone agate, yellow moss agate, mottled jasper, rainbow jasper

Third Row, Nine Stones
Smoky agate, onyx, green moss jasper, yellow and white moss agate, petrified palm root, moss agate, opaque green jasper, petrified wood, opallite

Fourth Row, Five Middle Stones
Brown moss agate, green moss agate, Montana ribbon agate, carnelian, highly agatized moss jasper

Bottom Row, Five Stones
Agatized jasper, smoky moss agate, flower agate, onyx, black and white moss agate.
specimen. It is then the student's job to grind the material down to the actual line on the 120 wheel, being careful not to chip the stone in the process. This should be done by holding the slab in the two hands, not using a dop stick. Light touches are all that are necessary as the stone approaches the outline shape of the future gem.

When the surplus material has been removed up to the desired shape of the outline, one side of the mineral must then be selected for the surface or top of the stone. The other side is smoothed off and made perfectly flat by holding it against the side of the 220 wheel. A light touch should be used and inspection often made to be certain that too much material is not removed when giving the back of the stone a smooth surface.

The process of shaping the top can be started on the 120 wheel, progressing to the 220 wheel.

It is important to have the pupil work the stone with his fingers rather than to try to dop the mineral and then go through the grinding processes, unless the stone is too small to hold firmly within the fingers. Better control is retained over the grinding of the stone by this method, and there is much less chance of fracture by the excessive vibration which a beginner would have in using the dop method at this stage.

When the stone is well shaped on the 120 wheel, it may then be taken to the 220 wheel for the smoothing-out
process, in preparation for the sanding disks. On the 220 wheel, the stone should be touched lightly to the face of the wheel and be kept moving all the time. To stop the stone even momentarily against the wheel will result in a small flat spot. Flat spots, if large, are very difficult to remove when starting the sanding processes.

At first, it will not be easy for the beginner to keep his specimen moving constantly when grinding the crown of the gem, but with practice he will soon get on to the technique.

To aid the beginner, the teacher should have him wipe the stone dry often and inspect it for trueness, for irregularities of the gem stone, and for other flaws that may need to be removed on the 120 wheel. The work must all be done by the judgment of the eye. The instructor will find few beginners who can grind their first specimens to true proportions. The teaching aid previously mentioned proves its value in getting across good proportions the first few times.

The finishing processes of the stone on the 220 wheel may make it necessary to place the gem on a dop to facilitate obtaining a more even surface and to remove flat spots. On the dop, a small stone can be spun more easily against the periphery of the grinder.

A small alcohol lamp is needed to melt the wax used in dopping a stone. If no lamp is available, a clean oil can may be used by cutting off part of the spout and
running a wick up through the remaining portion. Dop sticks are of different diameters, depending on the size of the cabochon itself. 1/4" to 3/8" dowel wood six inches in length will be adequate for most stones. Plenty of wax should be placed on the stick prior to doping the stone to the stick. Figure 1 gives a general idea of the amount of wax which should be on the stick and its desired shape before doping the stone.

The stone should be heated just enough so that it is too hot to hold comfortably with the fingers. A large pair of tweezers can be used in heating the stone, passing it back and forth over the flame. If the stone is overheated, it is apt to shatter. When heated, the stone is placed on a block of wood, bottom side up. The waxed stick is then held in the flame of the alcohol lamp and rotated rapidly until the wax begins to melt. At this point, the waxed end of the dop stick is pressed quickly against the hot stone and pushed firmly and evenly against the stone. The wax should be allowed to cool for about sixty seconds before working with the stone again. The hardening process may be speeded up by placing the dop stick in cold water for about ten seconds.
Black Devil Dopping Wax is a reliable wax to use. Ordinary sealing wax does not have the toughness to withstand vibration on the grinder or sander.

The dopped stone will look like the drawing in Figure 2, if properly dopped at the right temperature of both wax and stone. The wax should never extend to the edge of the stone if properly dopped.

Removing the stone from the dopping stick is a simple procedure, but care must be taken that the stone does not fly onto the floor and break. If the gem is fairly large, the dop stick is gripped firmly in the right hand, with the thumb pressing against the back edge of the stone. The surface of the stone should be held lightly against the palm of the left hand. Firm pressure is exerted with the right thumb against the stone, and it will "pop" off the dop stick.

If the stone is very small, the dopping stick with the stone on it should be placed on top of a thick piece of felt. The sharp edge of a knife blade is pressed firmly between the wax and the stone. Precautionary measures should be taken here, so that the stone does not fly
across the room or fall to the floor.

The gem stone should **never** be removed from the dop stick until it is a finished product.

**Drilling**

If the stone is to be used for a pendant, it is sometimes necessary to drill a hole in the gem. The best time to do this is before starting the sanding processes. A small drill press with a hand feed lever will work nicely in drilling the small hole in the stone.

The first step is to select a drill. Small tubing is best to use in this process and can be of brass, silver, or soft steel, about 1/32" to 1/16" in diameter, depending on the size hole desired. If a solid wire is used for the drill, it will triple the time ordinarily needed for the job.

The next step is to prepare the stone for the drilling process. The desired hole is located and around it a small puddle of doping wax is used to form a hollow in which to place the silicon carbide, 220 abrasive in paste form.

The stone is held under the drill press in a firm, level position. The drill should turn about 500 RPM for effective drilling. The actual drilling is not performed under constant pressure, but the drill is lifted every few seconds to allow abrasive to work under the drill. Only
very light pressure is needed, otherwise the drill will bend. Plenty of abrasive should be kept in the hollow, and caution should be taken to see that the stone does not heat.

If the specimen is to be a pendant that can be displayed from either side (i.e. heart-shaped), the drilling should be done from both sides to eliminate chipping the stone on one side. As the point of the drill emerges through the stone, it may flake off a small bit of material.

Different drilling abrasives will be needed on some minerals, depending upon their hardness. Norbide should be used for drilling small holes in any mineral above 7.5 in hardness. Norbide is hard and cuts fast. Diamond bortz is also used, but it is much more expensive than norbide. Silicon carbide will serve for all other purposes in drilling stones of 7 in hardness and below.

Sanding

The most important step in preparing a gem stone for the polishing process is sanding. It is here that the greatest number of mistakes and ruined pieces of work are apt to occur if a student does not have adequate instruction.

Both professionals and amateurs in time develop a technique of their own which seems to give them the best
results when sanding a stone. Some will carefully put each stone through every stage of sanding, while others will eliminate certain steps on certain minerals, thus expediting the processes, and have just as good a finish on the gem stone. The emphasis here will be on an elimination of as many steps as possible, still including all that are necessary for proper sanding results.

Many amateurs wonder why, when sanding a stone, the specimen is taken from the 220 grit grinding wheel and started on a 120 to 150 grit sanding cloth. This does have all the appearances of starting over again, or destroying what has already been accomplished. Jumping from the 220 grinder back to a 120 sanding disk is done for certain reasons that speed up the sanding processes. On the 220 grinding wheel, shape and design only are given to the gem stone. In grinding, it is impossible to give a stone a smooth, rounded surface so that no small flat spots remain. The stone comes in contact with too small an area of the periphery of the wheel. This makes it difficult even for the professional to remove the majority of small irregularities that occur at this stage of finishing the gem. It is not the purpose of the grinder to remove all of these very small flat spots from the stone, but to give the stone shape and good proportion in preparation for the sanding disks. However, the more care and time spent on giving the stone true proportion, reducing the uneven areas
on the rounded surface with the 220 grinder, the less time needs to be spent on the sanding disks trying to remove these defects. This, also, is economy in the saving of sanding paper.

Jumping from the 220 grinder to a 120 sander helps to cut down the flat spots at a greater speed than if the 220 or 280 sanding disks are used. If more time is spent trying to bring the surface to true proportion, the smaller the possibility of overheating of the gem by impatient students applying too much pressure over too long a period of time. Overheating will melt the wax, causing the stone to fly off the dop, or the stone may shatter under the extreme heat to which it is subjected.

The 120 sander will remove uneven areas at a good speed, reducing the chances of overheating, and at the same time the silicon carbide breaks down into finer particles, which actually is the beginning of the semi-polish the stone will have before going to the buffer. The sanding disks can turn at speeds of 1,000 RPM to 1,400 RPM. The harder the mineral, the greater the speed that can be used, but a safe range for the majority of minerals is around 1,100 RPM.

The gem stone is kept on the dop stick and should be touched lightly to the face of the sander, moving and turning the stone so one small area will not be subjected to excessive sanding. The stone should be tested frequently
for heating by holding it against the back of the hand or touching lightly on side of the face. It is handy to have a small pan containing water in which to dip the stone every few seconds. Some lapidists prefer to use speed wet sanding cloth, running in water as a cooling agent. However, this method poses more problems in the building of additional splash pans for the sanding wheels and is not necessary for a school setup.

When the stone is smooth with no flat areas showing, it is time to proceed to the 220 sanding disk. Very little time needs to be spent here if all uneven areas were removed first on the 120 disk. As the silicon carbide particles begin to break down on the surface of the 220 disk, the stone will start to take on a very smooth finish. The stone should be inspected frequently for extremely small scratches by being held up to a light to catch light reflection off the crown of the stone. Natural light is better for this type of inspection. When the stone has a dull shine, with no scratches, pits, or low spots on the rounded surface, the final sanding can be given with the 500 grit sanding paper.

The 500 grit will further reduce fine scratches which were not removed with the 220 disk, even though the naked eye cannot see them. This gives the gem its high semi-polish. It is to be remembered that the 500 sanding disk is for the purpose of giving a semi-polish only and not to
remove deep scratches or uneven areas that can be detected by the eye alone. Only a few minutes, three to five, will be necessary at the last stage of the sanding process if care was used in proper sanding in the first two steps.

Starting with a well-worn 120 disk, a cabochon sometimes can be sanded in two steps only, in preparing the stone for the buffer. Some stones may require four to five steps in the sanding process to get good results and to prevent undercutting as much as possible on those minerals where the consistency of hardness does not remain true throughout. With experimentation, the knowledge of proper and speedy sanding processes will soon develop. In the sanding processes, gem quality minerals can be determined with little doubt. If it is uncertain whether a choice-looking piece of rock will take the proper finish, a small fragment can be quickly ground off a little on one side, and the surface cut down on the sanders to a semi-polish. If all pits can be removed, no undercutting occurs, and the surface reaches a high, semi-polish, the mineral will take a final polish.

Provisions were not made to have a third sanding disk covered with the 500 sanding paper ready for use at all times. There are certain reasons for having the system this way in a school shop. Many of the students will not have the necessary patience or will not want to take the time to sand the stone properly on the 120 and 220 grit.
wheels. When such a student gets to the 500 wheel, he will invariably attempt to remove flaws for which the wheel was not intended. He wears out the 500 paper by applying more pressure rather than returning to the coarser papers to remove the flaw. It is here that the instructor should carefully inspect each gem stone to see that it is ready for the final sanding before giving out the 500 silicon carbide disk on which to do the operation.

Polishing

If a gem stone has been properly prepared on the sanding disks, the student will have little difficulty putting the very high polish on the specimen. However, there are certain types of minerals that will not take a proper polish. This may be due to the softness or extreme hardness of the stone, and special polishing processes will be needed to finish it.

There are many polishing powders on the market today, but the best by far for minerals up to the hardness of eight is cerium oxide, which can be purchased from any dealer in lapidary supplies.

Slightly convex wooden disks were found to serve the purpose of a polishing disk by glueing a 1/4" felt pad to the face and covering this with several layers of outing flannel. The flannel should be cut slightly larger than
the disk and placed over the felt. A steel rim can then be pressed around the disk, holding the flannel in place smoothly and evenly. When one cloth wears out, it can be torn off, and polishing continued with the layer underneath.

Many lapidists like to use the felt buff only, applying the cerium oxide directly to the buff. If dirt or grit works into the felt, a certain percent of the felt is removed by using the broad end of a 10" file sharpened like a screwdriver and supported over a rest. This rapidly cuts the surface of the felt away. This method of buffing is quite all right for the home work shop where only one person is using the disk. In the classroom, many will be using the buffer, and the replacement of felt is not nearly so easy as the removal of one layer of outing flannel for a clean new surface on which to buff.

One tablespoon of cerium oxide is mixed with one-half pint of water. This is stirred well and applied to the turning disk with a small brush. The mixture should be applied sparingly, otherwise too much will be thrown off and wasted. The stone is held lightly against the buff, turning the stone slowly in the hand. From time to time an additional amount of cerium oxide should be added. The stone should be wiped clean occasionally to inspect under a good light for dull spots or fine scratches. If there are fine scratches, the stone will need to be put through the last sanding step again. If the stone has been
properly sanded, no more than five minutes will be needed to put a beautiful high polish on the gem stone.

Tripoli powder and tin oxide powder can be used on some stones, but they take three to five times longer to get a high polish.

Many stones may be fibrous or soft or not of a compact nature, and special techniques are needed to obtain the final polish. For turquoise, the buff is allowed to run dry in the final buffing stages, care being taken that the stone does not overheat. For opals, extreme care should be exerted in not overheating and a dry and very soft buff with little compound should be used.

For soft stones, a felt buff may be used in the first stages of polishing, but a soft出てing flannel wheel should be used in the final stages to get good results. There are some grades of onyx, marble, and other minerals that refuse to take a high polish under any conditions unless a small amount of oxalic acid is added with the regular cerium oxide. Care must be used in applying the acid directly to the stone. If a piece of onyx is to be polished, it is brought up to the final stages of the polish, as far as can be gone without using oxalic acid. The acid is applied to the stone, and it is buffered for a few seconds. The onyx is then placed at once in clear water. With such soft minerals, the oxalic acid quickly breaks down the surface of the stone. During a short period of time, a high
SOME SUGGESTED CABOCHON SHAPES

(Any imaginable variation is possible)

PLAN

SIDE VIEW

DRAWING 5

Opaque stones often look best when cut with a flat base and a flat top, unless they are light in colour as is turquoise for instance.

Very translucent stones are brighter if both upper and lower faces are curved.

Opal and moonstone should be cut in high cabochon shapes to display their beauty.

Get your stone ground to the proper shape as soon as you can, thus avoiding much tedious grinding in the later stages.
polish can be given to the stone. Overpolishing will result in the removal of this finish, again leaving a dull finish on the stone.

It is always advisable to keep the mixed cerium oxide buffing compound in a jar that can be closed to keep out foreign matter. The brush should be allowed to remain in the jar, also, so it is always clean and ready for use.

**Facet Cutting**

Simple faceting can be accomplished in the classroom if the instructor does not allow the pupil to work with too small or too large a stone as a beginning. A fair degree of mechanical ability and plenty of patience are needed if one wants to become fairly good at the job.

A great number of amateurs are doing their own facet work now with a high degree of success. In the classroom, it would be out of the question to allow a student to try an American brilliant cut on any stone for which that style of cut would be applicable. A great amount of time and skill are needed to do this sort of work. However, there are simple facets on which the student can practice to attain some degree of skill and the knowledge that he will need if he plans on going further into the art of faceting in his spare time.

There are several methods used in cutting facets on
gem stones (16:p.47).

"1. The method where the gem is cemented to the stick or dop and then held by the hand against an upright post standing at right angles to the surface of the lap. This method is the oldest of all and has been in use for centuries.

"2. The second method consists of a mechanical device to hold the dop, to give various angles, and permit the gem to be rotated by mechanical means in placing the facets in proper position. This method is recommended for the 'amateur'.

"3. With the older method where the dop is held by hand, the angles of the various rows of facets are obtained by merely placing the end of the dop in the proper notch on the upright, which is termed jamb peg or gem peg. To do good work with this method, a certain degree of skill is called for, which can be acquired with practice and experience."

It is this third method of cutting facets that is stressed due to the cheapness of construction and easy adaptation to any lap. Drawing 6 of the jamb peg device is given on page 114.

In the use of the jamb peg facet device, a dopping block is needed to dop a gem to the stick properly. An improperly dopped stone will result in lop-sidedness, waste of time and material. A drawing (Drawing 7) of the V dopping block is given on page 115, along with the type of dop stick needed to crown dop the stone later. Also, the drawing shows what a roughened-out stone should look like.
THE WILLEM'S FACETING DEVICE

Drawing 6

The device consists of two separate parts: (1) The hand-piece, which carries a fish-tail at its upper end and a scale of 32 divisions surrounding the lower end; and (2) the adapter, which attaches to the hand-piece and is held in place by a set screw, and tapers down so that the stone to be cut can be attached by means of the usual lapidary's cement. The overall length is five and one-quarter inches, the diameter of the hand-piece is five-eighths of an inch, and the spread of the fish-tail is one inch.

The terminal end of the adapter can be made any diameter desired. Two sizes are desirable: One with a diameter of three-sixteenths inch for smaller stones and one 3/8" for larger.
1. Roughed out brilliant
2. Table dop
3. Crown Dop
4. Pavilion dop

Drawing 7
prior to dopping with the table top dop.

The table top of a gem is always completely ground and polished before any facets are cut on the stone. The order of cutting is given in drawing 8 on page 117, with the order in which the first eight facets should be cut. Staggering the facets prevents overcutting and undercutting and makes it easier to line up angles at which the facets meet.

The seventeen-crown girdle facets are cut next, following with the eight small crown table facets joining the table of the stone. The facets are cut on a tin or zinc lap, which is about 14 gage metal. When one side wears out or becomes badly scarified, the lap can be turned over and the other side used until it is worn out. This system prevents the necessity of having a cast iron lap turned down on a metal lathe frequently, which actually runs into great expense, unless it can be done in the school shop.

Norbide is the abrasive used in cutting down the facets to proper size and shape. When this has been accomplished, the facets are ready for the polish and are generally polished in the following order:

a. The eight crown table facets.

b. Main facets.

c. Girdle facets.

Cerium oxide or tripoli can be used as the cutting agent in polishing. This is a long and slow procedure that
FACET CUT STONES

PROPORTIONS OF THICKNESS

<table>
<thead>
<tr>
<th></th>
<th>DIAMOND</th>
<th>ZIRCON</th>
<th>CORUNDUM</th>
<th>TOPAZ</th>
<th>QUARTZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>1/3</td>
<td>35/41</td>
<td>43/40</td>
<td>37/42/3</td>
<td>43/40</td>
<td>43/40</td>
</tr>
<tr>
<td>2/3</td>
<td></td>
<td>40/40</td>
<td>42/3/4</td>
<td>44/40</td>
<td>44/40</td>
</tr>
</tbody>
</table>

STANDARD  BRILLIANT

Fig. 1  Fig. 2

Fig. 3  Fig. 4

Showing manner of procedure in facet cutting American brilliant style cut. (1) Table cut and polished (oversize), and four large facets. (2) Large facets divided to give 8 main crown facets. (3) (shaded portion) showing extent and correct position of crown girdle facets. The stone is numbered in the order the facets should be cut. (4) Standard brilliant
is done on a tin lap but gives excellent results.

After the crown facets are completed, the stone is removed from the dop stick and redopped on the pavilion dop stick. Care should be taken to see that the stone is mounted perfectly true before cutting the pavilion facets.

When cutting these facets, the worker must make sure that each of the eight main facets is lined up with the main crown facets. The sixteen pavilion facets are next cut, adjoining the girdle of the stone. The standard brilliant calls for fifty-seven facets, but additional ones can be placed on the pavilion, called the "culet" facets. The polishing is done in the same order as the procedure gone through in polishing the crown facets.

This system of cutting facets will serve for any stone having a table facet from which to work.

Cutting a standard brilliant takes skill and patience. Before attempting this, practice should be acquired on more simple cuts which require no more than eight separate facets, as shown on page 117.

There is much technical knowledge needed if good and proper faceting is to be accomplished. There are different procedures to use in faceting some gems, due to softness or extreme hardness of the stone. Also, to get the most light display from a gem, the optics of the mineral must be determined. This will require considerable research for the beginner. The technique of determining the optics
of gems is far too lengthy to be included in this study. It is recommended that the reader purchase a copy of *The Art of Gem Cutting* by Fred S. Young. This book contains reliable information on many phases of faceting and the optics of gems.
Glossary of Terms

Abrasive: A substance used for abrading as for grinding, polishing, etc.

Agate: A variegated chalcedony, having its colors arranged in stripes, clouds, moss, etc.

Alumina: Aluminum oxide occurring native as corundum, including sapphire, ruby, etc. When powdered, it is used as a polishing agent.

Arbor: A spindle or axle of a wheel. A shaft or bar for holding cutting tools.

Bortz (also Bort): Diamond dust; material consisting of imperfectly crystallized or coarse diamonds or chips or fragments made in cutting coarse diamonds.

Black Devil Wax: An excellent doping wax far superior to the majority on the market.

Brilliant: A diamond or other gem in a particular form with numerous facets so as to have special brilliance.

Cabochon: A stone cut in convex form, polished but not faceted.

Carat: A unit of weight for precious stones, especially diamonds and pearls, being 200 milligrams (3.066 grams troy). Also a 24th part; used to express the fineness of a gold alloy.

Carborundum: A manufactured abrasive. A trade mark for certain abrasives; hence, silicon carbide bearing this trade mark.

Carnelian: Refers to the reddish color of agates; a reddish variety of chalcedony.

Cerium oxide: Fastest polishing compound in the world today on stones up to the hardness of 8.5.

Charge: To set pieces of diamond into metal or impregnate diamond dust into steel or metal as in the periphery of a diamond saw.
Cleavage Plane: The plane through a diamond or certain other gem materials where it will cleave or split if grooved and struck with the proper blow.

Cradle Jig: A jig used to line up the dop or lap stick with the stone being faceted.

Crown: Of a gem is that particular portion of a gem above the girdle.

Culet: The small, flat facet, parallel to the table at the bottom of a brilliant.

Damascus Ruby Powder: A patented preparation especially suited for the gem materials which yield undue scratches when treated with tin oxide.

   2. Rod drill: A solid steel or brass rod with a piece of diamond imbedded in the cutting end.
   3. Tube drill: A tube of silver or other suitable material charged by tapping it into a small amount of diamond dust.

Faceplate: The metal disk or wood disk fastened to it which is screwed on to the live center of a lathe, either wood or an engine lathe.

Facet: One of the small, plane surfaces of a diamond (brilliant or other cut gem).

Faceting Device: A tool which will enable the user to present to the lap with certainty of correctness the area of a gem on which grinding is to be done.

Felt Wheel: A polishing wheel made of felt on which a polishing agent (as tin oxide) is used.

Flat: Refers to a flat place on the periphery of a mud saw; or refers to flat surfaces of gems or larger specimens of slabs or sections.

Front Facet: The top or upper facets of a brilliant cut stone or gem.

Gem: Any jewel; a precious stone, or sometimes a semi-precious stone, cut and polished for ornament.
Gem Peg: An approximate cylinder anchored in place above the face of the lap. It has many notches in its side and the tail end of the lap stick rests in one of the notches, giving the worker a firm rest for the lap. This scheme is widely used by professional cutters but very little by amateurs.

Grain Marks: Irregular scratches appearing on the surface of facets.

Girdle: Of a gem is the edge that bounds the widest part of the gem.

Grinding Head: The arbor and bearing supports of a grinder.

Impregnate: To infuse particles of another substance into: cause to be permeated or saturated (as of diamond dust into the periphery of the saw).

Jig: Any contrivance rigged up to assist in doing a job. In this case, two blocks with a "V" to line up a stone (being faceted) on the dop stick.

Lap: v. To cut or polish with a lap, as glass, gems, etc. n. A revolving disk of brass, lead, cast iron, etc. used to hold an abrasive powder on its surface for cutting glass, gems, etc.

Lapidary: Of or pertaining to the art of cutting stones. An artificer who cuts, polishes and engraves precious stones. The latter is also lapidist.

Lapis Lazuli: A stone, a complex silicate containing sulphur of a rich azure-blue color.

Lap Stick: A stick to which a stone or gem is temporarily cemented while it is being cut and polished. Same as dop stick.

Matrix: The natural material in which any metal, fossil, pebble, crystal, or gem is embedded.

Mud: The solution of clay flour or bentonite and abrasive (carborundum grains) used with a mud saw.

Muslin Wheels: Polishing or buffing wheels made by sewing several thicknesses of muslin together. Outing flannel may also be used.

Oxalic Acid: Used on soft stones to make polishing possible. Usually placed with the regular polishing liquid.

Pavilion: Of a gem is that portion of a gem below the girdle.

Periphery: The circumference or perimeter of a circle or other closed curvilinear figure.

Rear Facet: The bottom or lower facets of a brilliant cut gem or stone.

Refraction: The bending of light rays.

Roughing: Refers to the first rough grinding of a cabochon or brilliant to approximate shape.

Sander: A wheel or disk on which abrasive paper or cloth is fastened to polish stones or gems.


2. Carborundum Saw: Put out by the Norton Company. It has a shellac binder to give it some flexibility but not much. It is suitable for resawing material of low hardness.

3. Diamond Saw: A saw of body or cold rolled steel, phosphorus bronze, or spring brush copper in which bortz is impregnated in about 1/16" of the periphery.

4. Mud Saw: A saw for cutting rocks and minerals made of a disk of body or cold rolled steel. It runs in a thick soupy bath of water and abrasive.

5. Resaw: Any of the several types of rock saws used to cut up slabs and other thin sections.

Splash Pan: The pan which holds the "mud" for the mud saw or the pan or metal box under a diamond saw.
Slick Shellac: Ordinary orange shellac melted and allowed to harden into a solid bar. It is used for cementing gems and stones to the dop stick.

Swiss Lapis: Artificially colored (blue) chalcedony. Also sometimes called lapis lazuli.

Table: Of a gem is the upper flat facet of the gem.

Tin Oxide: The oxide of metallic tin. A fine, white powder used as the finishing, polishing agent in polishing gems and stones.

Translucent: Shining or glowing through - partly transparent.

Tripoli: Frittable, soft shistose deposit of silica, including diatomite and kieselguhr. It is mixed with a wax and used as a polishing agent.

Wheel Dresser: A tool with several revolving disks on a pin on one end. These disks are multiple pointed stars of very hard steel. It is used to true-up a grinding wheel by wearing away the high irregularities.
APPENDIX B

Copies of Questionnaires
January 8, 1948

To Industrial Arts or Craft Instructors:

For hundreds of years, the art of cutting and polishing stones was a closely guarded secret. It is only in recent times, with the development of new abrasives, that the processes used in this work have been made readily available to interested persons. Since such a rich art as the cutting and polishing of stones has an appeal for all ages, it seems worthy of inclusion among the crafts available through the industrial arts program of many schools.

Attached to this letter, you will find a questionnaire, which is part of a survey being made in high schools and colleges to determine how well lapidary work, the term used to signify the cutting and polishing of stones, will fit into the industrial arts program of our secondary schools.

It is not the intention of this survey to determine the commercial or vocational value of lapidary work but the educational value of its inclusion in industrial arts programs, to increase the pupils' avocational interests.

Such a study will obviously need to consider many channels, not the least of which is the opinion of selected educators, both within and outside of the industrial arts group.

We shall look forward to receiving your reactions to the questionnaire, at the earliest opportunity. Thank you for your cooperation in this matter.

Very truly yours,

Alva W. Oliphant
Coordinator
QUESTIONNAIRE

Form A - to be used if lapidary work is taught in your school, or if you have previously taught the work.

1. Is lapidary work taught as a special course in your school?
   Yes ___  No ___

2. What is the length of your course in lapidary work in hours per semester?

3. What number of students can you accommodate at one time on the lapidary machines?

4. Estimate the cost of your lapidary machinery to the nearest figure.
   $50  $75  $100  $150  $200  $250  $300

5. Do you offer lapidary work in adult education classes?
   Yes ___  No ___

6. Do you think lapidary work should be included in adult education classes?
   Yes ___  No ___

7. Are organized field trips used as a part of the work in your classes?
   Yes ___  No ___

8. What percent of the gem-cutting material do you purchase from supply houses? Use nearest percent.
   10%  15%  25%  50%  75%  100%

9. In your locality, has there been an increase in interest shown in lapidary work?
   Yes ___  No ___
10. In states that have an abundance of mineral wealth, do you think that lapidary work should be one of the courses to be offered in the crafts field?

Yes ___ No ___

11. In your opinion, what is the comparative value of lapidary work on the junior and senior high school levels? Check one in each column.

<table>
<thead>
<tr>
<th>Junior High Sch.</th>
<th>Senior High Sch.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Excellent</td>
<td>Excellent</td>
</tr>
<tr>
<td>Good</td>
<td>Good</td>
</tr>
<tr>
<td>Poor</td>
<td>Poor</td>
</tr>
<tr>
<td>Should not be</td>
<td>Should not be</td>
</tr>
<tr>
<td>offered</td>
<td>offered</td>
</tr>
</tbody>
</table>

12. In your opinion, of what value is lapidary work on the adult level? Check one.

Excellent
Good
Poor
Should not be offered

13. Do you include faceting in your lapidary work?

Yes ___ No ___

14. Please state briefly the degree of success with which lapidary work has met in your school.

15. Do you think an organized course of study for lapidary work is practical?

Yes ___ No ___

NOTE: Your prompt return of this brief questionnaire will be truly appreciated.
Form B — to be used by teachers who have never taught lapidary work.

1. Do you think lapidary work would be a desirable course to offer in the crafts shop?
   
   Yes ___ No ___

2. Is there a definite reason why lapidary work has never been included in your present crafts shop program? If so please state this reason.

3. Do you expect to add lapidary work to the crafts work in the near future?
   
   Yes ___ No ___

4. Is the school administration in favor of lapidary work being taught in the industrial arts program? If not, could you give two or three reasons?

5. Would you be interested in broadening your industrial arts background with a good course in lapidary work, if such a course were made available to you?
   
   Yes ___ No ___

NOTE: Your prompt return of this brief questionnaire will be truly appreciated.
QUESTIONNAIRE

Form C

1. In your opinion, do you think lapidary work would be a desirable course to offer in the industrial arts program of our secondary schools?

2. In your college, is lapidary work offered for:
   a. appreciation and personal enjoyment, __________; or
   b. as a craft course preparatory to teaching in the industrial arts or other fields.

3. Do you think lapidary work could be taught successfully as a separate course within the crafts field? If the answer is NO, would you please state your reason.

4. Has there been a definite increase of interest in lapidary work within your school in the past three years?

5. List three or four objectives which you expect to obtain by offering lapidary work on the college level.

6. Do you include faceting as one of the areas in your lapidary work?

7. What is your opinion of the value of lapidary work as a hobby?

8. Would a course in lapidary work fit well into adult education?

NOTE: Your prompt return of this brief questionnaire will be truly appreciated.
January 8, 1948

To Mineralogical Society Members:

Attached to this letter, you will find a questionnaire which is part of a survey being made to determine how well lapidary work will fit into the industrial arts program of our secondary schools. The information obtained will be used in a thesis, entitled "Lapidary Work as a Medium of Instruction for the Industrial Arts Program."

All who participate will be informed of the results of this survey by letter. If the results are unusually noteworthy, there will be a more expanded report in one of the professional magazines.

Enclosed you will find a stamped, self-addressed envelope to aid in the return of the completed questionnaire. An extra copy of the questionnaire is also enclosed, which you may wish to keep as a means of comparing your answers with the results of the survey as published.

Your cooperation will be greatly appreciated. It will be particularly helpful if the questionnaire is returned as soon after your next meeting as possible. Any suggestions or criticisms will be gratefully accepted.

Very truly yours,

Alva W. Oliphant
Coordinator
QUESTIONNAIRE

Name of Mineralogical Society____________________________

Address________________________________________________

1. In your opinion, is there a need for training young men and women of junior and senior high school ages in fundamental skills of lapidary work from the hobby viewpoint?
   Yes ___  No ___

2. Do you believe pupils would derive any benefit from taking a course in lapidary work in high school?
   Yes ___  No ___

3. Would it be desirable in your community to offer a course in lapidary work as one of the classes in adult education?
   Yes ___  No ___

4. In your area, are there enough deposits of gem-quality minerals to make field trips desirable and practical for a high school class in lapidary work?
   Yes ___  No ___

5. Has there been a definite increase of interest in the field of lapidary work in your locality in the past few years?
   Yes ___  No ___

6. Do you feel that cross-country trading of gem-quality minerals by secondary schools would be practical and desirable?
   Yes ___  No ___

7. Do you think lapidary work too expensive for the average person to have as a lifelong hobby?
   Yes ___  No ___

NOTE: Your prompt return of this brief questionnaire will be truly appreciated.
APPENDIX C

Copies of Letters
January 27, 1948

Mr. James L. Kraft
Board Chairman
Kraft Foods Company
Chicago, Illinois

Dear Mr. Kraft:

I have read in Fortune magazine of your interest in lapidary work. Because with you the work is a hobby of long standing, I am interested in your opinion of the value of lapidary work in high schools and in adult education classes in many of the classrooms of our country.

As you know, the trade secrets of this interesting work have become available to the layman only in recent years. As a result, many educators still consider lapidary work too technical and too expensive to include in the handicrafts field. Having taught lapidary work quite successfully on the secondary school level, I believe there is no finer hobby for youngsters - one which offers a challenge to excel, and which brings an opportunity for wholesome experiences both indoors and out. This is especially true of many schools west of the Mississippi River, where soil erosion and geologic formations have provided rich opportunities for gathering usable materials by field trips.

I am pursuing a study, entitled "Lapidary Work as a Medium of Instruction for the Industrial Arts Program." It would be particularly helpful to have your suggestions or criticisms on the educational value of such a course, if taught from the hobby viewpoint.

Thank you for your courtesy.

Sincerely yours,

Mr. Alva W. Oliphant
Chairman of the Board  
Kraft Foods Company  
February 2, 1948

Mr. Alva W. Oliphant  
Oregon State College  
Corvallis, Oregon

Dear Mr. Oliphant:

I have your letter of January 27th. As to the question of teaching lapidary work in the public schools, I am wondering on what basis you would recommend teaching this art. Do the boys and girls in the secondary school level have time to work just on a hobby? You will not find more than one in several thousand with sufficient aptitude to become a professional lapidary. Is teaching boys and girls a pure hobby considered good educational practice in these days? That is something I do not know.

I think if the public schools could open such a department for grown people who wish to pursue a hobby, who like the outdoors, and some of whom might develop into real high class workmen, that would be rendering a marvelous service to the community.

I am frank to confess that I am not up to date on the educational processes, but I do know that the studies laid out for boys and girls in schools from the secondary grade on to their graduation from college, presents a stiff course and occupies generally all of their time. How many of them will lay aside their studies to pursue a hobby, interesting as it may be, I do not know. I think this phase is something you ought to give careful consideration to.

Sincerely,

s/ J. L. Kraft
January 27, 1948

Dr. Ivan H. Crowell
Provincial Director of Handicrafts
Province of New Brunswick, Canada

Dear Dr. Crowell:

I am interested in your opinion of the value of lapidary work in secondary schools; also, in adult education classes.

As you know, the trade secrets of this interesting work have become available to laymen only in recent years. As a result, many educators still consider lapidary work too technical and too expensive to include in the handicrafts field. Having taught lapidary work quite successfully on the secondary school level, I believe there is no finer hobby for youngsters - one which offers a challenge to excel, and which brings an opportunity for wholesome experiences both indoors and out. This is especially true of many schools west of the Mississippi River, where soil erosion and geologic formations have provided rich opportunities for gathering usable materials by field trips.

I am pursuing a study entitled "Lapidary Work as a Medium of Instruction for the Industrial Arts Program." It would be particularly helpful to have your suggestions or criticisms on the educational value of such a course, if taught from the hobby viewpoint.

Thank you for your courtesy.

Sincerely yours,

Mr. Alva W. Oliphant
February 3, 1948

Mr. Alva W. Oliphant,
Oregon State College,
Corvallis, Oregon.

Dear Mr. Oliphant:

By all means, I feel that lapidary work in the secondary schools and in adult education programmes would make a most excellent project.

We are beginning to get underway here in New Brunswick. I feel very strongly that lapidary work for boys and girls would be particularly appealing.

I would like to know details about your programme so that we may apply them here.

Yours very truly,

s/ Ivan H. Crowell
t/ Ivan H. Crowell
Director of Handicrafts

IHC/R
Mr. Alva W. Oliphant, Coordinator
School of Engineering and Industrial Arts
Oregon State College
Corvallis, Oregon

Dear Mr. Oliphant:

We certainly regret that it will be impossible for us to fill out your questionnaire dealing with lapidary work for the simple reason that we do not have a single school -- public, private, secondary, or of college rank -- in the State of Texas that teaches lapidary work. As the President of the State Mineral Society of Texas, we are in a position to make the above statement with authority and with knowledge.

In order that you will get our thinking, we are going to answer your questionnaire as though we did have quite a good deal of lapidary work in the State of Texas. As a matter of fact, we have much gem material here in Texas -- the whole length of the Rio Grande River is more or less covered with moss agate.

Our reason for answering the questionnaire with the above explanation is none other than that we have visited many, many places teaching lapidary work. As a matter of fact, we trained four persons in New Mexico in the Teachers College at Silver City last year, and we are going to start lapidary work in some of our schools here in Texas.

Attached to this letter you will find our ideas concerning lapidary work, and incidentally, may we state that by all means silver smithing should be taught in connection with lapidary work; however, it should be a separate class.

Yours very truly

/s/ J. J. Brown
/t/ J. J. Brown, President
State Mineral Society of Texas
Form B - to be used by teachers who have never taught lapidary work.

1. Do you think lapidary work would be a desirable course to offer in the crafts shop?
   Very desirable course
   Yes ______ No ______

2. Is there a definite reason why lapidary work has never been included in your present crafts shop program? If so, please state this reason.
   Lapidary work has never been undertaken in Texas for the simple reason that we have only had any interest in lapidary work for perhaps two or three years.

3. Do you expect to add lapidary work to the crafts work in the near future?
   We expect to have lapidary work taught in some of our junior colleges, especially in the industrial arts department.
   Yes ______ No ______

4. Is the school administration in favor of lapidary work being taught in the industrial arts program? If not, could you give two or three reasons?
   School administrators, we feel sure, will favor lapidary work being taught in the industrial arts program.

5. Would you be interested in broadening your industrial arts background with a good course in lapidary work, if such a course were made available to you?
   We have an adult at the present time for whom we would like to secure training in silver smithing and lapidary work. The name of the person is Mrs. Kathleen Kitchell who is the daughter of Frank Duncan of Terlingua, who advertises in Rocks and Minerals, the Desert Magazine, and the Mineralogist. Naturally, you can see from our attempt to answer your questionnaire, the President of the State Mineral Society of Texas is highly interested in lapidary work being taught here in Texas.

NOTE: Your prompt return of this brief questionnaire will be truly appreciated.
LONG VIEW TOWNSHIP HIGH SCHOOL
Member North Central Association of College and Secondary Schools
H. H. Jarman, Principal
Long View, Illinois
Jan. 23, 1948

Dear Mr. Oliphant:

I have been doing lapidary work as a hobby and have been getting our high school pupils interested in it. We do not offer it as a course or part of a trades course as yet but will if we can get enuf interest aroused. We are doing it as a club. This is a perfectly flat country with no rocks of any kind except granite boulders brought in by glaciers years ago. The pupils know nothing about rocks or minerals and of course know nothing of gems and gem cutting. They never knew that you could take an ordinary looking stone and get a lovely gem from it. We have some material gathered on trips over the United States but must purchase most of it.

I don't know very much about the work so will appreciate it if you can help us in any way. We take the Mineralogist Magazine, Desert Magazine, Arizona Highways Magazine and have several books on minerals and gem cutting. Do you know of any state or government bulletins that are available?

Yours very truly,

s/ Harry H. Jarman
January 25, 1948

Dear Friend:

We at George Washington High School were pleased to hear of your interest in our study in lapidary work. As yet, we have not been able to advance our work to any great extent, but with the enthusiasm of the students, we are encouraging more of this type of work.

At present, this art is being taught in night school and daily classes as an extra subject. The Rock Hounds have been organized as a lapidary club to encourage the interest of young people in that type of work.

We feel that education in this field should be greatly widened and hope that this will help you in your survey.

Yours very truly,

s/ E. G. Anderson
<Mr. E. G. Anderson>
Art Crafts Instructor

Alva W. Oliphant
Oregon State College
Corvallis, Oregon

THE ROCK HOUNDS
Washington High School
10860 South Denker Avenue
Los Angeles 44, California
Opalene Mineral Society
Marsing, Idaho
P. O. Box #167
January 15th, 1948

Mr. Alva W. Oliphant
Industrial Arts Dept.
Oregon State College
Corvallis, Oregon

Dear Mr. Oliphant:-

I wish to present a few facts in addition to the questionnaires why we think that there is a need for training young men and women of junior and senior high school ages in the fundamental skills of lapidary work from the hobby viewpoint.

1. It is now estimated that there are some 800,000 persons doing lapidary work as a hobby in the U. S. A. Most of them belong to mineral and earth science societies. These societies belong to federations - namely "The Northwest Fed. of Min. Soc." etc. Now these district federations will be united into a national federation and will soon hold an annual convention.

2. The handiwork of the individuals in the lapidary art are displayed at these federation conventions. The Northwest Fed. Convention held in Boise, Idaho, in 1946 was a great success and the 1947 convention that was held in Seattle, Wash., was one of the greatest displays of lapidary art ever shown in this country and some 15,000 persons attended and viewed the displays.

3. "The Lapidary Art" was a trade secret for centuries until the amateur lapidary hobbyest took over. He is the one who discovered and built new equipment, discovered and improved new methods and found new gem deposits and minerals here in the U. S. and other countries.

4. Many of these hobby craftsmen cut valuable quartz wafers for the Gov't. during the war for radar and radio instruments etc.
5. Many of the schools in the Eastern U. S. conduct successful lapidary and jewelry making classes in their high schools and junior high schools. It is very popular with the students and many turn out articles of fine workmanship. The schools in the Northwest, Rocky Mt. states, and Southwest could easily conduct successful classes in lapidary art and jewelry making. Lapidary art should hold the same high level as music, painting and other arts as it ranks as one of the oldest arts that man has practiced.

6. There are splendid deposits of fine gem materials in many localities of the N. W. and especially in Oregon, Idaho, and Washington. These deposits can be visited on field trips.

7. Many or most of the mineral societies would be willing to sponsor and help the high school classes in getting started.

8. There are many junior groups affiliated with the mineralogical societies and many of these young people are doing excellent work of collecting and displaying minerals as well as cutting and polishing gem stones.

9. Mining of minerals as well as agriculture has built the economic resources (industries) of the U. S. and the study of minerals and lapidary work by our young people will not only offer an interesting hobby but may start many on successful jobs as geologists, mineralogists, etc.

10. Many of us have collected and studied minerals for years as a hobby but when a person once finds a gem-stone and then successfully cuts and polishes the same into a beautiful gem then and then only does he or she fully realize the value of this hobby. Very few people ever relinquish this hobby when they once get started. It grows with a person year after year.

11. Most commercial houses furnish schools with discounts on gem material (rough) and on equipment. Most equipment can be built and assembled in school work shops by various other classes. For instance, plans can be drawn and wooden benches can be built and mechanical devices, etc. can be planned and built by other classes or departments.
12. There are many fine books of jewelry making, gem-craft, etc. Much fine material and equipment is available.

13. It trains the students in a useful hobby and one which will occupy their hands, eyes and minds and will give them something that they will not find in any other hobby.

14. Mineralogical society members of all walks of life make field trips into the mts. and deserts in search of gem materials which affords splendid outdoor recreations and fellowship. Rock hounds are always welcomed by other rock hounds wherever they may happen to be in the U. S. A. or in any foreign country. Many individuals have built up collections over a period of years that are worth many thousands of dollars and in case of an emergency these collections can be turned into ready cash to meet such an emergency.

15. Many splendid collections built by amateur lapidary hobbyests are in some of our largest museums and schools throughout the U. S. Our civilization and our very lives are dependent on minerals and the study of them is essential to everyone.

Sincerely,

Emil W. Pape, Jr., Sec.
Opalene Mineral Society
Alva W. Oliphant, Coordinator,
Industrial Arts Department,
Oregon State College,
Corvallis, Oregon.

Dear Sir:

Your letter was addressed to West Coast Mineral Society, Emerson Stanley, Secretary, which was correct. But he lives in Garden Grove and I in Fullerton, so the letter came to me and I opened it and am making the return.

I was enough interested in the idea that I took the trouble to make inquiry of seven different high schools and two junior colleges. And I took it up with our mineral society on the evening of Feb. 10th.

None of the junior or senior high schools were interested although they all thought it all right to have in adult night school courses. I also took the questionnaire to two mineral dealers and they both thought that it should be in the adult group. There would be nothing to prevent any youngster from attending night school if he is sufficiently interested.

No one can educate a hobby into a child. Children may be temporarily interested as they are in many things. But as lapidary equipment is costly and easily damaged it should be used only by people who will take care of it.

Most of the deposits of suitable material are so located that it would take two-day trips to get it. But there are several localities in which satisfactory material can be had.

As to cross country trading, it is felt that too few people would be willing to send good material. The average results of trading will be found to be unsatisfactory.
Any hobby that is worthwhile is expensive, either in time or money. While the capital investment in good shop equipment should be rather high, the real cost of lapidary is in the field trips and in the time spent in cutting and polishing. When someone does get specimens that are good the cost and effort will be repaid in pleasure.

Probably the most dissatisfaction arises from the purchase of too cheap tools. They will purchase or make a cheap saw and grinders and buffers. They will not be discarded and better equipment acquired so as to be able to do the best of work.

Hoping this may be of some value, I am,

Very truly yours,

s/ Chas. S. Knowlton
Dear Mr. Oliphant,

Your letter and questionnaire have been forwarded to me at my new address, as you will note above.

I am taking the liberty to answer your questionnaire as I have been associated with the Orange Coast group from the beginning, having organized the society last July at our place in Corona del Mar. The opinions expressed and the answers given are, I'm sure, the consensus of our group.

Since moving to the desert it has been necessary for me to resign as president of the society. Robert Neece of Laguna Beach is now president. Mrs. C. W. Smith of Corona Del Mar is Secretary-Treasurer. Erwin Tonne, to whom you addressed your letter, was formerly field trip chairman.

Perhaps you would like to know something of the beginning and activities of the society. Our first thought was that there was a need to organize like-minded rockhounds. Many of them had the interest but lacked the "push" to get started. We figured 30 to 35 persons might have an interest. Our first turnout was 55! Our society after six months now boasts a paid-up charter membership of over 120 rockhounds. In addition to this we are sponsoring a junior rockhound group, organizing with the help of scouts and schools.

Meetings are held once a month and a field trip conducted once a month to a gem or mineral area. One of our trips was attended by over 100 collected to a kunzite mine at Pala.

In my opinion there isn't any hobby that can surpass the lapidary and mineral interest. I believe that some instruction in mineralogy and gemology should accompany any instruction in lapidary. In that way values of materials are learned and the desire to get in the field and collect your own is fostered.
We are attempting here at our new location to further the interest in the lapidary and jewelry crafts, having set up a workshop for both. Our shop is just across the street from where the Desert Magazine is being built.

If you do not already subscribe, may I recommend the Lapidary Journal for help in your work. We can furnish back copies and subscriptions.

I sincerely congratulate you on your choice for a thesis. If I can be of any further help please feel free to ask.

Cordially,

Howard M. Barnes
("Barney")